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ELECTRICAL MEASURING INSTRUMENTS.

THERE is no dearth in the design of measuring instruments, though ofttimes it may be difficult to discover the advantages the new possess over the older forms. At the last meeting of the British Association Sir William Thomson exhibited quite a batch of new instruments, Prof. Forbes introducing at the same time a new coulombmeter. A week ago, at the Society of Telegraph-Engineers, Dr. Fleming described new forms of voltmeter and wattmeter; while Profs. Ayrton and Perry exhibited a new form of Cardew voltmeter.

Measuring instruments may be broadly divided into two classes: first, those intended to be used in the laboratory as standard instruments for the purpose of checking from time to time instruments in everyday use; and, secondly, instruments intended for ordinary installation work, which are put up and left in place, being removed only at long intervals for the purpose of reference to a standard.

In the former class should be included all zero or non-indicating instruments in which the movable part is maintained in one definite position, the current or difference of potential being measured by the force required to so maintain it. Sir William Thomson's electric balances are examples of zero instruments, as are also the Siemens dynamometer, Cunynghame's ammeter, and Fleming's voltmeter and wattmeter. These instruments are of very little use for installation work, as they do not indicate directly current or difference of potential. Before a reading can be taken the observer must go and balance the movable part of the apparatus, a most objectionable requirement in actual work. Exception must be taken to the Siemens dynamometer, this having been until recently the only instrument which could be used for the measurement of alternating currents to give results even approximately accurate. But, with this exception, all zero instruments are out of place for installation work, an instrument which gives visible indication of the exact current or difference of potential from moment to moment being what the attendant really requires for his guidance.

But regarded as a standard instrument we do not consider that the voltmeter of Dr. Fleming constitutes any advancement. The current is taken through the controlling spring, in our opinion a distinctly retrograde step and not essential, since in finely wound instruments of this class no difficulty has been experienced in conveying the current to the movable part. True the mercury cups have been dispensed with, but it is only in current-carrying instruments that mercury cups are necessary, a helix of very fine wire always giving for voltmeters a connection flexible and frictionless. The connection between the movable and fixed parts in instruments carrying heavy currents has always been the trouble, and until Sir W. Thomson introduced the elastic ligament which, supporting the movable part of his balance, furnishes a perfectly flexible conductor, mercury cups formed the only practicable means of connecting them together. Dr. Fleming objects to the use of electro-magnet instruments on account of their magnetic memory, the indication given by such instruments always depending on their past history. We agree with Dr. Fleming that for standard instruments the use of iron is to be condemned; but at the same time we think his new instruments are no better, though no worse, than several others already in the market.

In introducing their new development of Cardew voltmeter, Professors Ayrton and Perry laid great stress on the portability of their apparatus; but it seems to us that this is precisely the point of least importance to users. In nine cases out of ten the voltmeter is fastened on the wall and remains there, giving continuous indication of the difference of potential at its terminals until, due to an abnormally high E.M.F., the fuse melts, necessitating its temporary removal for a fresh one to be inserted. The new instrument, which we hope to illustrate shortly, is decidedly ingenious; but whether in the case of the wire breaking it can be as easily repaired as the present form, is a question the answer to which will go far towards determining the extent of its usefulness. Though the uncertainty of the readings near zero has been effectually overcome by a spring practically frictionless, such uncertainty compared with the greater facility for repairs is a small matter, and users will no doubt take this into consideration when deciding on the form they will adopt. But whether the old form or the new is selected, undoubtedly the Cardew voltmeter is at the present time the only practical instrument for the continuous indication of alternating electromotive forces.

AN attempt is being made to float "Armstrong's Electric Light and Power Company, Limited," with a capital of £20,000, to work the Armstrong primary battery. Of this sum the vendors take only £10,000; which, seeing that the "electronite" powder is included, seems quite a modest sum. But, joking apart, when will this primary battery craze cease? Will the British public never realise that the purposes to which primary batteries can be put are limited?

AMONGST other things, the Trade Mark of the battery is thrown in for the above sum, and a fine trade mark it is. Flashes of lightning, arrows, and stars make up a design which, we presume, may be taken allegorically as representing the stars which the shareholders will probably see.

THOUGH the names of *three well-known electricians* who tested the battery are carefully suppressed, the names of Mr. Jas. Sivewright and Mr. F. H. Varley are given, their reports being instructive in their way. In

making out reports the great thing appears to be to say a deal, withholding, at the same time, such figures and facts as would enable the discriminating investor to judge of the scientific or commercial value of the invention. In the reports before us this has not been lost sight of, and if men can be found who will pay the price asked for the patents the circumstance becomes explicable, as we remarked some weeks ago, only on the supposition that Thomas Carlyle's dictum respecting the people of this country is quite true.

WHATEVER the faults of the "ordinary domestic," she can always, according to the inventor, manage a primary battery. The latter has been the means of discovering more hidden virtues in the British slavey than any other invention whatever. At last she is admitted to have one redeeming feature, for however complicated the apparatus, she can work it perfectly. Amongst her advertised accomplishments, therefore, we may expect to read soon: "accustomed to the management of primary batteries."

MR. ALEXANDER WATT, Author of "Electro-deposition," "Electro-metallurgy," &c., has now completed his series of papers in the *Electrical Review*, on the Electrolysis of Cobalt Salts, in which he has given the results of a great number of experiments with this interesting metal, and has endeavoured to explain the probable reasons why Cobalt has not received much recognition at the hands of the electro-plater. From Mr. Watt's point of view, this metal should take its place as a substitute for nickel for coating various articles, its superior whiteness, and the readiness with which it may be deposited by electricity, being urged in its favour.

THE Electrical Power Storage Company has issued a pamphlet in which its automatic system for the public supply of electricity from storage batteries is compared with the transformer method, the writer being naturally biased very much in favour of the former. There is much to say for and against both; but on the whole we think the arguments advanced on behalf of storage batteries are in the main correct, and that but few people will be found to challenge the author's deductions. The disadvantages and dangers which can never be wholly eliminated from the transformer system with its high tension alternating currents are fully exposed, and there is much in the little brochure of practical interest to the commercial man, to whom it appeals rather than to the technologist. Nevertheless we commend it to the notice of all classes of our readers.

THE figures given in an estimable contemporary on the percentage of affirmative to negative answers received to certain questions which have been greatly agitating a small portion of the electrical fraternity for some few weeks past, reminds us of a circumstance which happened not very long ago. A line of telegraph had been erected in a far distant land, and the prospects of good business appeared very remote indeed, when, to the surprise of all outsiders, it was announced that the second months' traffic showed an increase of 300 per cent. over the first. It was afterwards explained that during the operations of the first four weeks only one message had been transmitted, but that during the second and similar period no less than three had been summarily disposed of.

A CORRESPONDENT asks us whether the question of the right to use compound-winding on dynamos is not in the same uncertain state as before the settlement of the Anglo-American Corporation *v.* Crompton case. Of course it is. No legal decision has been given, and it is open to anybody who refuses to recognise the claims put forward by the Corporation to go on using compound-winding if he does not fear the result of a legal suit.

MR. SHIPPEY has sent us a lengthy communication on the subject of Mr. Webster's challenge to a primary battery competition, and he suggests that the editors of this journal should be appointed jointly with the representatives of our highly esteemed contemporary the *Electrician*, as arbitrators, and he also enumerates the conditions under which he is prepared to enter for the fray. We appreciate at its due worth the compliment Mr. Shippey pays us, but cannot clearly see our way to take an active participation in the matter as it now stands. We have our own ideas of the kind of tests to which primary batteries should be submitted, and surely our correspondent cannot for one moment think that either we or his opponents would allow the competition to proceed on his own terms.

THE *East Anglian Times*, of the 26th ult., devoted a leader to a reflection upon the electric transmission of power on the continuous current dynamo transformer system of Paris & Scott. Some of the writer's utterances are worth reproducing, and our Ipswich contemporary may be congratulated on having a gentleman on its staff so evidently at home with electrical technicalities. Says he: "To light houses at Rushmere, for instance, they would carry from the central engine station a small copper cable about the thickness of telegraph wire. The smaller wire gives higher energy, the electricity dashing along it like a stream confined in a rocky channel. On the thick roomy wire the electric current has space to flow along like a broad and placid river. On the narrow wire it becomes confined and impetuous, and on reaching its destination would smash the delicate lamps, and act generally after the manner of torrents. So the electricians use the vigorous power thus produced as a motive force, turning with it a dynamo, which generates fresh electricity of its own. The thick, shorter wire carries, as it were, direct light, though you cannot see it as it goes along the street. The small long distance wire conveys power and energy from which light is made." Further on, his flights of fancy soar yet higher, and attain a sublimity, the grandeur of which is perfectly astounding. "For 50 years we have had the giant among us, and are at last getting to manage him. His nature, however, remains as inexplicable as ever. The professors have studied with all their patience of research, but are little nearer the truth. Does the first molecule of copper in the long wire get a knock which it passes all along, ninepin fashion, to the end, agitating all the molecules, and producing the invisible something which we call the current; or does the copper rest quiescent, and is it the ether between the atoms of the metal which is agitated and set in motion? Are we sure indeed that the current goes inside the wire at all; may it not go outside, taking the form of excited atmospheric atoms all along the line? By the way, there must be two wires to carry the current, not one, for electricity has its married state, negative and positive, each requiring to travel on its own line, instead of using the same road, like good husband and wife. There is nothing visible to distinguish the negative current from the positive. We only know that the two exist, and, though intimately allied, must be kept carefully apart." American papers please copy.

ELECTROLYSIS OF COBALT SALTS.

By ALEXANDER WATT.

(*Concluded from page* 529.)

Oxalate of Cobalt.—A solution of this salt was prepared by adding an excess of oxalic acid, in solution, to a neutral solution of sulphate of cobalt; the resulting pink liquid was electrolysed with the current from two small Daniells, when only a slight film of cobalt was received upon a brass cathode. Three cells in series were next tried, when there was a brisk evolution of gas, and a bright deposit of good colour slowly formed upon a newly prepared plate. The anode surface was considerably in excess of the negative electrode, under which conditions deposition progressed fairly well.

Oxalate of Cobalt and Ammonia.—A solution of this salt was formed by digesting oxalate of cobalt in a strong solution of carbonate of ammonia, with the application of heat; a pink liquid was thus obtained, which was then allowed to cool, and was next decanted and electrolysed with a single Daniell cell; with the current from this, however, there was no metallic deposit upon a brass plate, but much gas was given off. Two cells yielded similar results; when a third cell was connected, however, a very brilliant and silvery white film was obtained, which continued bright at the edges throughout the experiment. After a quarter of an hour's immersion of the cathode, the deposited metal attained a striated character, probably due to the rapid ascent of hydrogen bubbles on the surface of the plate. Although the liberation of hydrogen was exceedingly abundant, and the solution weak, the metal deposited with some rapidity. On examining the deposit at the end of half-an-hour or so, it was found that the film on the edges of the plate was as bright as silver that has been "scratch-brushed," while the surface within this boundary was alternately composed of dull and bright streaks, the former somewhat predominating. The deposited metal appeared to be somewhat harder than that obtained from some other solutions. The anode surface was about double that of the cathode, while the former electrode appeared to have been freely acted upon.

Carbonates of Cobalt and Potassa.—To prepare this compound, a solution of sulphate of cobalt was precipitated by another of carbonate of potassa, and the resulting precipitate well washed. The carbonate of cobalt thus obtained was afterwards digested in a strong solution of the potash salt, when a considerable proportion of the cobalt salt became dissolved: after filtering, the liquor, which was of a violet colour, was electrolysed with the current from three Daniell cells in series, when there was a vigorous evolution of gas at both electrodes. A bright, but somewhat dark film of cobalt was slowly obtained upon a brass plate, which was very adherent. During the action, an insoluble opaque salt, of a pink colour, formed on the anode.

Cobaltate of Ammonia.—This salt was prepared by precipitating a solution of sulphate of cobalt with ammonia, adding an excess until a considerable proportion of the hydrate at first formed was dissolved, when a deep brown solution was obtained, which was afterwards diluted with water. With the current from three Daniells, a prompt deposit of cobalt was obtained upon a brass plate; this, however, soon assumed a dark colour. There was no perceptible liberation of gas. The bath was next diluted by a further addition of water, when the coating became still darker, and eventually black, at which point the experiment was abandoned.

Cyanide of Cobalt.—A solution was prepared by digesting freshly precipitated hydrated oxide of cobalt in a strong solution of cyanide of potassium. The hydrate was very sparingly soluble, and from the resulting solution only a trifling film of cobalt could be obtained with the current from three Daniells; at the same time an opaque salt, of a pink colour, formed upon the anode. There was a good deal of gas liberated at the cathode.

Cobaltate of Potassa.—Recently precipitated hydrate of cobalt was added to a very strong solution of caustic potassa, when it immediately became dissolved, forming a purple liquid, which appeared red by transmitted light. When diluted with water, the solution became colourless, and a greyish flocculent precipitate formed. When an excess of the hydrate was added to the potash solution the liquid also became colourless, while the whole of the cobalt appeared to be thrown down in the form of a somewhat light grey powder. The purple solution yielded a deposit of cobalt of good colour, with the current from three Daniells in series, the film adhering well to the brass cathode.

Boettger's Cobalt Solution.—The formula for this solution is given as: Chloride of cobalt 40 parts, sal-ammoniac 20 parts, liquid ammonia 20 parts, and water 100 parts; but it is evident that a solution of this strength would be unsuitable for the practical deposition of this metal. Boettger recommends a current from two Bunsen cells for depositing cobalt from this solution: but if the liquid were considerably weakened, and nearly all the ammonia omitted from the formula, the solution could then be advantageously worked with the current from two Daniell cells.

Beardslee's Cobalt Solution.—Mr. Beardslee, of Brooklyn, New York, employs from four to six ounces of dried chloride of cobalt to each gallon of water, the solution being rendered alkaline by ammonia, with the current from two to five Smee cells—a current, we should say, that would be far in excess of that which such a solution would require to yield a good adherent coating of cobalt upon either copper or brass.

Sulphocyanide of Cobalt.—A solution of this salt was prepared as follows: A quantity of sulphocyanide of potassium was dissolved in alcohol, and to this was added a strong solution of sulphate of cobalt, when a dark blue liquid was produced, which was then set aside for a short time until the sulphate of potash formed during the decomposition had settled down. The clear alcoholic solution was next poured into a capsule, and the spirit expelled by evaporation, when a dense blue liquid was obtained which became solid on cooling. The dried mass was next dissolved in water, when the blue colour vanished and a bright pink solution resulted. With the current from three Daniells in series, a slight film of cobalt was obtained upon a brass plate, and after a few minutes a green gelatinous mass formed on the upper part of the cathode, which rapidly disappeared in the liquid. A second plate was now immersed, and a larger anode surface exposed, when a film of cobalt formed on the lower part of the plate, while the surface above became coated with a graduated, adherent film of a dark brown colour, the darker portion of which was nearest the upper surface of the plate, and terminated in a dark, iridescent horizontal streak. After a few minutes the solution became decomposed.

Persalts of Cobalt.—According to Brande,* hydrated peroxide of cobalt does not yield salts. I find, however, that when the newly prepared hydrate is used in its still moist state, that it is more or less readily soluble, both in dilute mineral and vegetable acids, provided that such acid solutions are employed while at nearly a boiling temperature. To prepare a series of these salts, a quantity of hydrated peroxide was first obtained by adding a filtered solution of chloride of lime to another of sulphate of cobalt, when a deep black precipitate was at once formed. The precipitate was next well washed on a filter and allowed to drain, when the resulting black and pasty mass was ready for use.

Percitrate of Cobalt.—A solution of this salt was obtained by adding to a boiling hot solution of citric acid, in small portions at a time, a quantity of the fresh hydrate; heat was then applied, when in about one minute or so, the hydrate disappeared and a pink solution formed. Further additions of hydrate were then given, until the solution was nearly, but not quite, neutral. From this liquid no deposit of metal could be obtained with one Daniell cell, or with two in series.

* Manual of Chemistry, by William Thomas Brande, F.R.S., &c., &c., Vol. I., page 788.

With three cells, however, and by warming the liquid, a film of cobalt slowly formed on a brass plate, which was of a fairly good colour and very adherent. A good deal of gas was liberated at the cathode.

Pertartrate of Cobalt.—A solution of this salt was prepared, as the last, by dissolving the hydrated peroxide in a strong and hot solution of tartaric acid, when a liquid of a lilac colour was obtained. Electrolysed with three cells the still hot solution yielded a slight film of cobalt on a brass plate. From this and the former solution practically the same results were obtained.

Peroxalate of Cobalt.—An electrolyte was prepared from this salt, which was formed, as before, by dissolving the hydrated peroxide in a strong and boiling hot solution of oxalic acid. The hydrate dissolved very freely in the acid liquor, with effervescence, yielding a dark green solution. With the current from three cells there was a white film obtained upon a brass cathode, and a copious evolution of gas. There was no perceptible difference in the results from the last three experiments.

Peracetate of Cobalt.—This solution was prepared by dissolving the hydrated peroxide in a hot solution of commercial acetic acid, when a brown liquid was obtained. This, after being filtered and diluted, was electrolysed with the current from three cells, when a bright film of cobalt of good colour was obtained upon a brass plate soon after immersion. There was, however, a good deal of gas liberated at the negative electrode.

Pernitrate of Cobalt.—This was prepared by digesting moist hydrated peroxide of cobalt in a hot dilute solution of nitric acid—about one part acid to 15 parts of water—when a red liquid was formed, which was then set aside to cool. The solution was afterwards electrolysed with the current from three Daniell cells, when a slight film of cobalt gradually formed upon a brass cathode. After a short time a black, non-metallic coating was deposited upon the film, which came away from the plate in flakes. A second plate also received a trifling film of metal, but after a few minutes' immersion it became coated, as before, with the black deposit.

Perchloride of Cobalt.—This was prepared, as before, by dissolving the hydrated peroxide in a hot solution of dilute hydrochloric acid, when a dark green liquid resulted. The hydrate dissolved very freely in the hot acid liquor. On adding cold water to the hot green solution it immediately became pink in colour. The clear solution, when cold, was decanted and electrolysed with the current from three Daniells, when a very bright and white film of cobalt was obtained upon a brass cathode, but the deposition progressed but slowly. There was much gas given off at the negative plate.

Persulphate of Cobalt.—A hot dilute solution of sulphuric acid was first prepared, to which was added hydrated peroxide, a little at a time, heat being applied after each addition, until the acid solution was neutralised. As in the former cases, the hydrate did not appear to dissolve until the liquid became near the boiling point, when it disappeared immediately, forming a pink solution. Electrolysed with three cells, a very white and adherent film was obtained upon a brass cathode.

Perphosphate of Cobalt.—Hydrated peroxide of cobalt was digested in a boiling solution of phosphoric acid for about 20 minutes, and the vessel then set aside to cool. The clear liquid, which was almost colourless, was next decanted and electrolysed with three Daniells, when a slight film of cobalt was received upon a brass plate. After a short immersion, the solution nearest the anode acquired a pink colour, from the formation of a protosalt.

Perborate of Cobalt.—To prepare this solution, a strong and boiling solution of boracic acid was first prepared, to which was added hydrated peroxide of cobalt, and the solution again boiled for a few minutes. When cold, the clear liquor was poured off and electrolysed with three cells, when a bright film of cobalt, of good colour, was deposited upon a brass cathode almost immediately after immersion. The result of this experiment shows that even so weak an acid as boracic acid is capable of dissolving a small percentage of the hydrated peroxide of cobalt.

In reviewing the results of the foregoing experiments from a practical standpoint, I find that the following solutions are most suitable for the electro-deposition of cobalt for the various purposes of art, namely, the sulphate, the double sulphates of cobalt and ammonia, the chloride, the double chlorides of cobalt and ammonia, and the chlorides of cobalt and sodium; with either of these solutions very good results can be obtained, provided that too strong a current be not employed. Respecting the electro-deposition of this metal, it has always struck me as being somewhat remarkable that it has found so little favour amongst electro-depositors. Indeed, from enquiries which I have lately made, it appears that little or nothing is done in the way of cobalt plating. The manager of one well-known firm assured me that he had a desire to adopt cobalting as a branch of his business, but that, from some cause or other, he failed to obtain good results with the baths he had prepared; this is doubtless the case with many others, and I am disposed to think that the chief, or probably the only cause of failure, has been due to employing too strong a current; and in arriving at this conclusion I am prompted by the fact that one writer on this subject states that "from two to five Smee's cells are required" to deposit cobalt from a solution of the chloride, whereas I have found that the current from two small Daniells is quite strong enough to deposit this metal from the chloride solution; indeed, a single cell of this battery causes an instantaneous coating of cobalt to deposit on a brass cathode, even with an anode surface of the same superficial area. This being the case, the employment of five, or even two, Smee's, cannot be expected to yield favourable deposits of this metal. Again, when we bear in mind that even the most feeble electric current will cause the reduction of the metal from most cobalt solutions, it will be at once manifest that any considerable increase in the strength of the current must injuriously affect the character of the deposit. As an illustration of the readiness with which some cobalt solutions yield up their metal by electrolysis, I will mention an experiment which I made in this direction a few days ago. Two short lengths of wire, one copper and the other zinc, were fastened together by a piece of thread, the copper wire being allowed to project about half an inch beyond the zinc wire. The couple, thus arranged, was dipped into a solution of the double chloride of cobalt and ammonium until the zinc wire just touched the liquid, while the copper wire was, of course, half an inch below it in the bath. The wires were steadily held in this position for about half a minute, when on withdrawing them it was found that the copper wire had received a coating of cobalt. If, therefore, a current so feeble as that which would be set up under such conditions is capable of reducing cobalt from its double chloride solution, may we not assume that any great departure from these conditions must be likely to influence the nature of the deposit unfavourably, and consequently render the practical deposition of cobalt as a business not only difficult, but impossible? In submitting these views I am endeavouring to account for the probable cause of this metal not having been accepted as one which should take its place in the workshop of the plater. If I am in any degree right in my conjectures, will it not be worth while for some of our intelligent electro-platers—nickel-platers, perhaps, more especially—to turn their attention in this direction, and endeavour to introduce cobalt-plating, for coating some articles at all events, as a substitute for nickel-plating? It may be urged against this that cobalt is a dearer metal than nickel. This is admitted, but since a cobalt bath requires but little more than one-third of the quantity of "salts" required to make up a nickel solution, the cost of the bath would be about the same. The price of cobalt anodes, however, is considerably higher than those of nickel, but if we

take into consideration the very small amount of metal that is deposited upon the work, even when the plating is of the best, the cost of the metal actually put upon the work is scarcely worth consideration. Another argument in favour of cobalt plating, or cobalting, which would be a more suitable term, is this: the public like novelty, and their admiration for nickel has somewhat cooled down; a whiter metal, and one nearly, if not quite as hard, would therefore doubtless meet with attention, and tend to give a fillip to the electro-plating industry, one branch of which, nickel-plating, has been sorely depressed for some time in consequence of an unfair system of competition, set up by some persons who provide "outfits" for nickel-plating. These persons having "outfitted" a great number of firms, at an enormous cost in each case for plant, dynamos, and materials, not being satisfied with the huge profits arising out of such transactions, started nickel-plating at their own establishments, merely to show off their dynamos and attract custom for plating materials, while the prices they charged for nickeling were all but nominal. In a very short time after this unfair system was adopted, the *bonâ fide* nickel-platers, who had paid large sums to these "outfitters"—frequently as much as one thousand pounds—found that their customers demanded a fabulous reduction in prices, and quoted the terms charged by these outfitters as a warranty for their demand. In this way—and I am writing from an actual knowledge of the fact—the whole of the nickel-plating industry of London, at least, has been deeply and irreparably injured by the very persons who started them in the trade! As a defence against this gross abuse of commercial enterprise, I would urge all nickel-platers to turn their attention to cobalt, and to purchase their anodes and salts direct either from the manufacturers, or from such firms as are well-known *not* to be platers themselves.

THE LIGHTING OF THE BRIGHTON PAVILION.

AT last week's meeting of the Brighton Town Council, the question of the electric lighting of the Pavilion was discussed at length. The committee presented a special report to the effect that they had, in pursuance of the instructions of the Council, caused the whole of the leads and wires and the appliances for lighting the Pavilion and Dome by electricity to be reinstated in accordance with Mr. Preece's specification, as approved by Mr. Heaphy on behalf of the insurance offices, and that when the repairs and alterations were completed, as they would be in the course of a week or two, the installation would again be in working order. The committee had also been in negotiation with the Brighton Electric Lighting Company, Limited, with a view to a contract with them for the supply of electricity, and they now begged to report that an offer had been made on behalf of the company to supply the Corporation with the necessary electricity for the incandescent lamps in the Brighton Pavilion at the rate of one halfpenny per 45 watt lamp per hour. This charge included the renewal of worn-out lamps, and was worked out at the rate of elevenpence per Board of Trade standard unit (1,000 watt hours). The new wiring now being installed at the Pavilion necessitated the use of different lamps from those previously employed and for which they had estimated in the above tender. They now renewed their offer, modifying it to the new requirements, and basing it on the following stipulations, which they suggested as being necessary: —"(1) The supply contract to be for a minimum period of one year, after which it may be terminated by the company on any June 30th, or by the Corporation at any period, on giving one calendar month's notice in writing. (2) The company's charges to be divided into three parts, viz.:—(A) A variable charge depending solely upon the consumption of electricity in the installation. (B) A stated annual charge to pay off the costs of installing the necessary apparatus, instruments, and running the necessary wires. (C) An annual charge for maintaining the installation in repair, cleaning the lamps, general attendance, and replacing any lamps that may be broken or worn out with new lamps, to be supplied by the Corporation. (3) All the instruments, converters, and outside wires installed by the company shall remain the property of the company and be removed by them on the termination of the contract. (4) The system of supply and the tension of the electricity supplied to be approved by the Corporation and the fire insurance offices. (5) The time for the supply of electricity to be from half-an-hour before dusk (or at any earlier hour if required by the Corporation, of which requirement an hour's notice will be necessary), and to continue during the night for as long as at least 30 lamps are burning. (6) For every failure to supply the required electricity from the company's mains, a penalty of £2 to be paid by the company. (7) The consumption of the electricity to be checked by having the time the various lamps are alight recorded on proper forms to be placed at the various switches." The company also stipulated that the cost of fitting up the necessary apparatus should be paid by three annual instalments, viz., at the expiration of the first year, £80; at the expiration of the second year, £50; at the expiration of the third year, £30; total £160; and in the event of the contract being terminated before the expiration of the third year, the unpaid balance of the above amount of £160 to be paid by the Corporation. The annual charge for maintaining the installation in good repair, cleaning and putting up the new lamps supplied by the Corporation in place of broken ones, and having a competent man in attendance, would be £60 per annum. With reference to the offer made by the Electric Lighting Company, the Borough Surveyor (Mr. Philip C. Lockwood) presented a report as to the comparative cost of lighting the Pavilion by electricity by using the engines and apparatus already fitted in the yard on the west side of the Corn Exchange, and by having the electricity supplied on the terms already detailed. He pointed out that the number of lamp hours required per annum would, of course, vary much, according to circumstances, but he assumed that 400,000 lamp hours per annum might be taken as a fair estimate of the quantity of lighting which would be required. The cost of supplying this quantity upon the terms proposed by the Electric Lighting Company would be as under:—400,000 lamp hours at 10d. per Board of Trade unit (which would equal about ·45d. per lamp per hour), £750; charge for connection, rent of meter, &c. £80 (this charge would be reduced in the second year to £50, and the third year to £30); renewal of lamps, £100; annual charge for cleaning and attendance, £60; total, £990. If the work was done by the Corporation engines he estimated the cost as under:—Labour and superintendence, £250; repairs to machinery, coal, wood, oil, waste, &c., £300; renewals of lamps, £100; total, £650. Neither of the above estimates included interest on the capital already expended, and if the Corporation engines were set to work again he thought that a water purifier should be provided, the cost of which would be £150. If that suggestion were acted upon, a sum of about £10 a year in respect of the outlay of capital should be added to the annual cost, making £660. The committee pointed out that according to the report of the surveyor the Corporation could themselves light the Pavilion by electricity at a much less cost than would be incurred if the company's offer were accepted, and accordingly recommended the council to carry out the work themselves.

Alderman ABBEY, in moving a resolution in accordance with the committee's recommendation, urged that the price asked by the company was excessive, and they could effect a saving of £330 a year by carrying out the work themselves. As to the question of electricity *v.* gas, there was no doubt that the former was absolutely necessary if fashionable entertainments were still to be

held in the Pavilion. With gas the rooms became excessively hot.

Councillor BERRY observed that he would go with the committee if they could afford some assurance that in the course of a few months they would not be moving for new plant. Otherwise it would be better to adopt the company's offer, knowing exactly what they would have to pay.

Councillor BOOTH replied that no member of the Corporation ever thought of purchasing new plant.

Councillor BROADBRIDGE could not understand how they were going to accomplish the electric lighting for £600 now, whereas with the same plant it cost them £900 a short time ago.

Alderman SENDALL pointed out that the sum of £900 included interest on capital, a sum amounting to about £200 a year.

Alderman MAINWARING mentioned that several improvements had recently been effected in the engine, which would enable them to produce electricity at a reduced cost.

Considerable discussion followed, during which Councillor HALL pointed out that they were disregarding Mr. Preece's advice in not having accumulators. He did not believe in the comparative estimates, and prophesied that within a year they would be in favour of putting the matter in the hands of a company.

Eventually the resolution embodying the committee's recommendations was carried without a dissentient.

THE ELECTRIC LIGHTING OF TRAINS ON RAILWAYS.

THE electric lighting of moving trains has hitherto been kept in abeyance by the difficulty of finding a method capable of meeting all the exigences of the case. We therefore take the opportunity of bringing before our readers a brief account of the system devised and carried out by the Electrotechnical Works at Cannstatt, in Würtemberg—a system which is already in practical use on the lines belonging to the Würtemberg Government.

The conditions for lighting a train in motion are very stringent. It is necessary that the light must be independent of the speed and the direction of the train, and must not be affected by a stoppage. How long a stoppage may last without injury to the light depends on circumstances, but in view of possible obstructions on the line provision should be made for several hours. The locomotive must also be capable of removal without interfering with the light, nor must any difficulty occur in case of one or more carriages being detached from the train or coupled on at junctions.

In this latter case arrangements must be made for the introduction of carriages which are fitted with electric lamps, but which have no appliances for setting them in action.

The installation must not require the services of a special electrician attached to the train, but must be capable of being managed by the ordinary officials. Hence all complication must be avoided. As a matter of course, economy and efficiency must be kept in view.

It must now be considered what arrangements must be made to fulfil these various requirements. It might seem very simple to light up a train on the principle of a stationary installation, fixing on the locomotive a steam motor and a dynamo and feeding the former with steam from the boiler. But if this is done the locomotive cannot be uncoupled without extinguishing the light. It has also been proposed to dispense with a special motor and take the power for driving the dynamo from an axle of the train.

In either case, to be provided for the possibility of stoppage, it is necessary to have at hand accumulators which can be charged whilst the train is in motion, and can keep up the supply of light during a stoppage.

We have three possible combinations of systems. We may work whilst in motion and during a stoppage with a special motor and employ accumulators when the locomotive or some of the carriages are detached, or when fresh carriages are coupled on. Or, secondly, we may drive a dynamo from the axle when the train is in motion, falling back under all other circumstances upon accumulators. Or, lastly, we may use accumulators in all cases. The third of these systems would, on lines with many branches and sidings, require a great number of stations where the accumulators could be charged. The first system renders necessary a great number of locomotives fitted with special motors and dynamos, or else with steam-tight pipes and couplings to work a separate motor in the luggage van.

The second system requires no special production of fuel; the dynamo serves simply as a brake and utilises a part of the *vis viva* of the train hitherto expended uselessly.

The practicability of the electric lighting of trains, therefore, depends for the present on the utility of the accumulators. The questions arising are the relation of weight to duty performed, the losses when at work and when standing, the safety of action, the duration and the cost of procuring the accumulators and keeping them in action? The first of these questions is best answered in connection with the fourth. The accumulators used by the Cannstatt firm and constructed by De Khotinsky, of Rotterdam, present the following features:—Model A_5 has a capacity of 300 ampère-hours and lasts at the maximum charging and discharging current (48 ampères) $\frac{300}{48} = 6{\cdot}2$ hours.

Its dimensions are $34{\cdot}5 \times 51 \times 18{\cdot}5$ centimetres, and it weighs with case and cover (but without acid) 63 kilos (cover 4 kilos), and when charged with acid 77 kilos.

This accumulator gives a result of 630 volt-ampère hours $= 630 \times 3{,}600$ volt-coulomb $= \frac{630 \times 3600}{9{\cdot}81}$ $= 231{,}000$ kilogrammetres.

As regards the fourth and fifth questions it is pointed out that accumulators are frequently injured by over-charging and over-working. But the fault of the rapid destruction of an accumulator depends often on the manufacturer. It appears that a battery of accumulators remained for two years in good order, whilst another battery, from the same makers and similarly treated, gave way in three months. The De Khotinsky Company guarantees the positive plates of their accumulators for two years; the negative plates last much longer.

The Bernstein lamps used by the Cannstatt Works consume per normal candle 3·7 volt-ampères, or per second 3·7 volt-coulombs. Hence the accumulators above described yield per kilo of total weight 7,954 second-normal candles, or per cubic-decimetre in bulk 18,800. In other words, per kilo of total weight we obtain one normal candle for 2·2 hours, or per cubic decimetre of bulk for 5·2 hours.

As to the loss of electricity when at work and when at rest, the Khotinsky Company guarantees a yield of 75 per cent. of the electric work delivered into the battery, and of 90 per cent. of the quantity of electricity employed in charging. No exact determinations have been made as to the loss of electricity when not in action.

Safety in working, that is security against sudden, unforeseen disturbances is chiefly liable to be endangered with accumulators by short-circuiting. This arises by the opposite electrodes coming into direct contact, or by a portion of the effective material becoming loose and wedging itself in between them. Of all accumulators those made by the Khotinsky Company are said to afford the greatest security against this mischief.

As regards the first cost an A_5 accumulator, as above described, costs at the manufactory £4 2s. 6d. This comes to 1·98s. per normal-candle hour. The cost of maintenance according to the prices fixed by the Khotinsky Company is 5s. yearly for the positive plates and 2s. 6d. for the negatives, or 7s. 6d. yearly. In addition come freight and the charge

for inserting new electrodes which have to be borne by the consumer.

As regards the manner of working the Cannstatt Electro-technical Works they prefer to let the dynamo run with a variable number of rotations in accordance with the speed of the train, *i.e.*, they drive the dynamo directly by band from the axle of a carriage, and arrange electrically that the current thus produced is kept within proper limits. The batteries of all the carriages are arranged in parallel circuits. Since it cannot be assumed when putting a train together that all the individual batteries are in the same condition of charge, the question arises whether such a general parallel arrangement occasions inconveniences on charging or discharging. Experiment brought to light the following properties of accumulators thus arranged :

1. If a discharged and a charged battery are introduced in parallel circuits, there is set up a compensatory current towards the discharged battery. This compensatory current is of short duration, and is of importance only in the very first moment. The tension of the weaker battery soon reaches that of the stronger.

2. If two batteries in parallel circuit are charged, the weaker receives a somewhat stronger charging current.

3. In discharging, the bulk of the common current is furnished by the battery which has the stronger charge.

These properties tend, as will be seen, to equalise differences orignally existing in the batteries. To a certain extent the several batteries aid each other.

The dynamo gives no current unless the speed of the train exceeds 30 kilometres per hour (= 18½ miles). So long as this is not the case, the connection between the dynamo and the accumulators is interrupted, in order that the accumulators may not discharge themselves into the dynamo. The arrangement by which this is effected cannot be rendered intelligible without the aid of illustrations.

The dynamo is so constructed that it may give a current in the same direction whether working forwards or backwards. This is effected by means of brushes placed perpendicularly upon the collector, and which at every change of the direction of the train, *i.e.*, of the direction of the rotation of the machine, are carried by the friction into a position suitable for the direction and the strength of the current.

The arrangements described can be modified in the most varied manners. Three systems have been in particular developed as the final result of the experiments at the Cannstatt works, and have been accordingly patented.

As regards the cost of establishing and working on the above principles nothing of universal validity can be said, as the size of the train and the hours of the day or night when it is arranged to run have to be taken into consideration.

The costs of the electric lighting of a railway train depend on :

1. The size of the train, *i.e.*, the number of carriages of which it consists at the outside.

2. Number and strength of the lamps required in each carriage.

3. Daily time available for charging the accumulators.

4. The reserve of stored up electricity which it is desirable to have at command when not in action by day.

5. The system to be adopted.

The cost is here given of lighting a train of 14 carriages, such as run on the main lines of the Wurtemberg Government railways.

A. The train consists of a goods van, conveying the necessary machinery, but serving also for luggage ; a second van, without machinery ; two first and second class carriages ; one large and one small second class carriage ; six third class carriages ; and two post-office carriages.

There are then arranged :—

Two vans each with two 5-candle and two 3-candle lamps.

Two first and second class carriages each with three 5-candle and two 3-candle lamps.

One large second class carriage with three 5-candle and two 3-candle lamps.

One small ditto with two 5-candle and two 3-candle lamps.

Six third class each with four 3-candle lamps.

Two post-office carriages, each with four 12½-candle and one 3-candle lamps.

B. Or, if the platforms are not illuminated, and no more light is required than is now obtained with gas :—

Two vans with each three 3-candle lamps.

Two first and second class carriages each with four 3-candle lamps.

One large second class carriage with three 3-candle lamps.

One small ditto with two 3-candle lamps.

Six thirds with each two 3-candle lamps.

Two post-office carriages with each four 12½-candle lamps.

This gives a total in the first case of 63 lamps = collectively to 295 normal candles ; or, in the second case, 39 lamps = 193 normal candles.

The cost of the outfit, if each carriage has two sets of accumulators and the dynamo serves merely for charging, and, therefore, whilst light is needed, one set discharges itself into the lamps, whilst the other is being charged, and the light always remains constant, is in the first case, £776 2s., *i.e.*, per carriage, £55 19s. : or, omitting the cost of machinery, £41 8s. ; and per normal candle, £3 2s.

If we take the second case, these figures become : £616 17s., £44 1s., £37 14s., and £3 11s.

If in a train of the same size the arrangement is so that one set of accumulators is charged by daylight and these accumulators feed the lamps from sunset to 9 p.m., *i.e.*, in winter five hours, and then the dynamo comes into play, and the accumulators serve only during stoppages or when running slowly, the first outlay is, if, as in A, the platforms have lamps at 3-candle-power, and the first and second class carriages lamps at 5-normal-candles, the cost is £652, and per carriage, including machinery, £46 11s. 6d., or per normal candle, £2 4s.

If the same number of lamps is arranged as in A, but with only one set of accumulators, which serve the lamps only when travelling slowly or when stopping, but which for the sake of a reserve are selected of the same size as in the former case, the total first outlay is £609, or per carriage, with machinery, £43 10s., or per normal candle, £2 1s.

If only lamps of 3-candle-power are arranged in the interior of the carriages, as in B, serving the lamps with the accumulators up to 9 p.m., the outlay will be £515 19s., and the normal candle will cost £2 13s. 6d.

The total working cost for 2,100 hours lighting yearly (from 6 a.m. to sunrise, and from sunset to 11 p.m.), vary according to the different arrangements, as indicated above, varies from 2·39s. per hour to 1·38s., and the hourly cost per normal candle obtained is from 0·91 to 0·60 of a shilling.

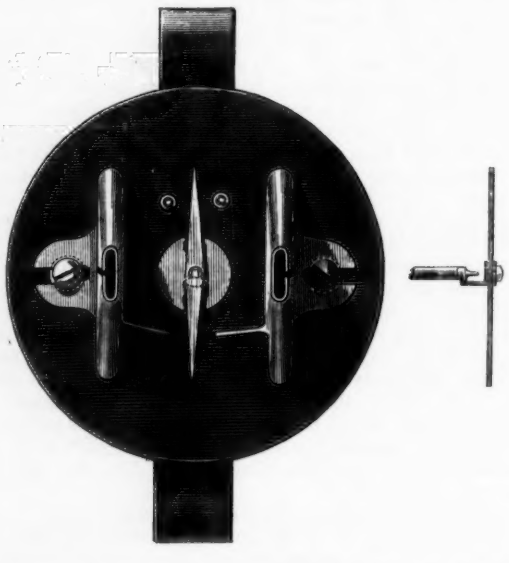
Prof. Kittler gives the following formal opinion on the Cannstatt system. After recapitulating that the carriages are lighted by Bernstein glow lamps, fed by Khotinsky accumulators, and that the batteries which supply the lamps are not, while in action, connected with the dynamo, which in the meantime is engaged in charging the reserve batteries, he concludes that the entire arrangement is simple, without complications, electrical or mechanical, and its action is therefore sure. The light is free from pulsations, and its brightness is sufficient, though it can be increased at pleasure by a corresponding selection of glow lamps. The use of two sets of accumulator batteries furnishes a sufficient reserve for unusual cases. The simple connection allows of an expeditious addition or removal of carriages to or from the train. The management of the entire system can be committed to any railway guard. The accumulators employed—as recently constructed—have given satisfactory results in practice. The tension of the current employed (16 volts at the glow lamps and

24 at the machine), is absolutely free from danger. All risk of over-heating may be avoided by means of fusible circuit-interruptors. Various improvements in detail are conceivable, which, however, do not affect the principle of the system.

GILBERT'S BRIDGELESS SINGLE-NEEDLE DIAL.

MR. A. E. GILBERT, Telegraph Superintendent of the Highland Railway Company, has recently brought out a new form of single-needle dial, for which he claims important advantages.

The idea of the inventor is to dispense with the usual bridge in front of the dial and to have the pivot inside, so as to avoid dust getting on the latter, the dust (according to Mr. Gilbert) causing the needle to stick to one side or the other; the arrangement is also said



to increase the sensitiveness of the needle. A further improvement consists in the jewelling of both the back and front pivots, the extra cost of which is very trifling. These dials (which are shown by the fig., which is self-explanatory), are manufactured with sounders complete by the Silvertown Company, and, it is stated, give the greatest satisfaction. It may be added that in some cases a brass sounder is fixed on one side and a tin the other for distinction; but as a rule there is sufficient distinction between both of the same metal.

THE DEVELOPMENT OF THE MERCURIAL AIR PUMP.*

By Prof. SILVANUS P. THOMPSON, D.Sc., B.A.

WITHIN the range of the physical sciences there are many subjects of interest to the investigator, some of them of importance in the technical industries, which yet are little known, save to the close student of scientific literature. An idea occurs to some original worker, who makes experiments, records results, draws inferences, and embodies his investigations in a memoir or note in the more or less obscure journal of proceedings of some scientific society, where it remains buried amid a heterogeneous mass of like matter. A few years later another worker, not knowing what has been done, stumbles across a similar idea, constructs his apparatus, makes his experiments and observations, and in turn consigns his work to a similar temporary oblivion. Years after, or it may be centuries, the progress of science in other departments reaches a point where it touches the unremembered work of those who are gone. Were that work available, were even a plain clue to its existence known, it would be at once brought into line and made useful. For want of such a clue it remains buried, and the world has to wait for some other to re-investigate what already was a portion of acquired knowledge; and the useful application to industrial purposes is delayed—perhaps for years. He who will explore the dusty corners of science, will hunt up the hidden treasures, arrange them, co-ordinate them with more recent knowledge, and render access to them easy for the busy workers around him, performs a service which, though it brings no renown, is at least useful.* In such dusty corners of science lie the scattered fragments of the literature of the mercurial air pump.

All true mercurial air pumps are, of course, based upon the principle of the barometer; that is to say, in all of them the vacuum is constituted in the manner invented by Torricelli, namely, in an enclosed space above a barometric column. In all of them the object is to render the Torricellian vacuum as perfect as possible. In some of them the object is effected by driving the air upwards out of the barometer head by raising the barometric column; in others, the air is forced downwards by the injection of more mercury into the barometer head. In others again, the air is pushed up one barometric column and down another. In some recent kinds of mercurial pump, several of these forms are combined. Other pumps again depend on the injection of mercury at high pressure through an orifice. These distinctions will furnish us with a basis for classification. Before attempting this, however, a few general historical notes may be given.

In 1643, Torricelli discovered the possibility of producing a vacuum above the top of a mercury column, by filling with mercury a tube closed at one end and then inverting it into a cup containing mercury. Until 1650—a period of seven years—when the mechanical air pump was invented by von Guericke, there was no other way of producing a vacuum, and the Florentine academicians, who made in the interval many experiments on the properties of vacuous space, employed as their pump a Torricellian

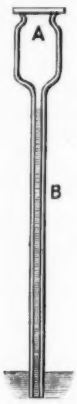


FIG. 1.

TUBE USED BY FLORENTINE ACADEMICIANS FOR EXHAUSTING.

tube (fig. 1) enlarged at its upper part into a bulb or reservoir closed at the summit by a cover, luted on with some suitable sort of cement. The apparatus is figured in Daguin's "Traité de Physique," vol. 1, p. 278 (edition of 1855). Writing in 1855, Daguin states that though the employment of the vacuum obtained by the lowering of a mercury column had been perfected by Baader and by Hindenburg, their machines required such a large quantity of mercury that they had been abandoned in favour of the mechanical air pump. The Torricellian method of exhaustion was pursued, however, whenever a very perfect vacuum was required, for example, by Count Rumford,† in his researches upon the propagation of heat. The bulb to be exhausted he sealed to the top of a barometric tube having a constriction near the top; it was then filled with hot recently-boiled mercury and inverted, when the mercury left the bulb vacuous. It was then sealed off before the blow-pipe just as exhausted glow lamps are sealed off to-day. An arrangement almost identical with that of the Florentine Academicians was suggested as a novelty so late as 1810, by Traill.‡ In 1845, Edward A. King § patented the construction of an incandescent electric lamp, having a carbon pencil situated in the Torricellian vacuum at the upper end of a barometer tube, a further suggestion being made for sealing the exhausted lamp. Amongst still more recent methods of producing in a glow lamp a

* Read before the Society of Arts, Wednesday, November 23rd.

* The author here desires to express his indebtedness to the many friends who have assisted in collecting this information; also to the valuable paper by Herr E. Bessel-Hagen, referred to in the text. He also desires to refer to a memoir by Prof. Hellmann, of Riga, a copy of which he received only after the greater part of this paper was already compiled.

† Rumford. Essays, vol. ii, p. 393. (Edition 1798.)

‡ Traill. "Nicholson's Journal," xxi., pp. 63 and 161.

§ King. Specification of Patent, No. 10,919, 1845.

Torricellian vacuum without the aid of any specific pump, may be noted that of André,* who seals the lamp globe to the top of a barometric tube, another short tube opening into the bulb being sealed on above. Mercury is driven from below until it fills the lamp, when the upper tube is temporarily stopped, the mercury being then lowered, creating a vacuum into which the occluded gases are liberated; the mercury is then raised, and these gases expelled through the stopper, and the lamp is sealed at the top; then the mercury is lowered and the lamp is sealed off at the bottom. Swinburne† has also tried this method, but has not found it successful. None of these processes of utilising the Toricellian vacuum amounts to the invention of a distinct Torricellian air pump. Although most of the mercurial air pumps to be described started from the fundamental notion of producing a barometric vacuum, it seems possible, if not probable, that some, at least, of the various forms had a different origin. Two of the main defects of the ordinary mechanical air pump, are the faulty packing of the pistons and the unavoidable clearance space between the piston and the end of its cylinder. It naturally occurred to several experimenters, possibly to many, that both these defects might be obviated by covering the piston with a layer of mercury. Air pumps thus provided with a mercury packing have been described by Kravogl‡ for exhausting, and by Régnault § and Cailletet for compressing. In the following sketch, however, attention is confined to the barometric species of pump. It will be convenient to classify these machines under the following heads:—

CLASSIFICATION OF MERCURIAL AIR PUMPS.

I. Those which drive the air up a barometric tube.
II. Those which drive the air down a barometric tube.
III. Those which drive the air up one barometric tube and down another.
IV. Combination pumps.
V. Injection pumps, dependent in their action upon the velocity of efflux of a stream of mercury.
VI. Mechanical mercurial pumps.

Under the first three of these classes there are sub-classes comprising "shortened" pumps.

CLASS I.—UPWARD DRIVING PUMPS.

The oldest of all mercurial air pumps belongs to the class in which the air is forced upwards above the top of a barometric column. It was invented by Emanuel Swedenborg, the famous

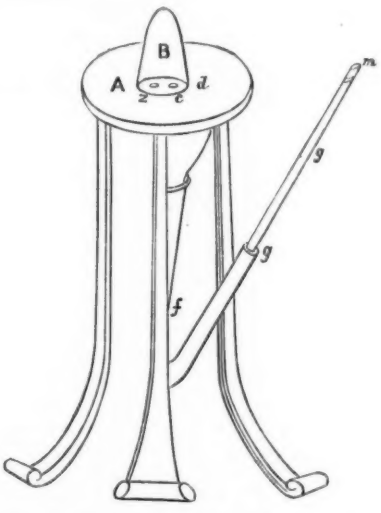


FIG. 2.—SWEDENBORG'S MERCURIAL AIR PUMP.‖

theosophist, and is described in his "Miscellanea,"¶ published in 1722. The apparatus and a drawing of the machine is given, which is reproduced in fig. 2. A glass receiver, B, stands upon a plate, A, as in the ordinary mechanical air pump, and the plate, A, is supported on three legs forming a tripod table. "Beneath this table," to follow Swedenborg's own words, "there is a certain conical vessel, E, of iron, hollow, and accurately fixed on the under side of the table so that it includes two apertures, *c* and *d*, furnished with valves." The valve *c*, opens downwards, the valve *d*, upwards. The lower end of the iron vessel ends in a flexible leather tube, *f f*, to which is adapted a piece of iron tube, *g g*, ending in an open mouthpiece, *m*. This iron tube was to be alternately raised and lowered precisely as is done in the modern Geissler or Toepler pump with the mercury vessel. Swedenborg's instructions are precise.

"OPERATIO.—Immitte mercurium vivum per (*m*), illa copia, ut repleat (*f*) (*f*) et aliqualem partem E; si dein sursum levas (*g*), tunc mercurius ascendit in E usque ad mensulam: si dein demittis idem (*g*) infra altitudinem 28 pollicum, tunc descendit mercurius in E, attrahit secum aërem ex recipiente per valvulam (*d*), et sic levando et demittendo, dum omnis aër sit exantlatus. Habeas etiam foramen quoddam in (*z*) sub mensula, quod aperias ope trochleæ, et immittas aërem cum velis."

Further instructions say that the lifting must be continued until some drops of mercury come out at *d*. The nature of the valves, *c* and *d*, is not stated; they appear to have been such as were used in the current form of mechanical air pump.

In the above description and figure, Swedenborg's lettering is adhered to, but it may be convenient to state that in all the following cuts the lettering adopted is as follows:—

A.—The "pump head" or hollow globe, which is filled and emptied.
B.—The barometric column or tube, also called the "shaft" of the pump.
b.—Barometric gauge.
D.—Drying apparatus.
E.—Eject tube or valve.
F.—"Fall tube."
G.—Gauge.
g.—The flexible lifting tube connecting S and B.
H.—Overhead tube.
J.—Mercury valve.
K.—Collecting chamber.
L.—Pressure chamber at bottom of shaft.
M.—Second chamber for partial vacuum.
N.—"Side tube."
P.—Piston.
p.—Plug of rubber.
R.—"Receiver."
r.—Regulating pinch cock.
S.—"Supply vessel," or reservoir of mercury.
s.—Rubber packing.
T.—Tap.
t.—Air trap.
U.—The valve opening inwards from the exhaust tube to the lower end of the pump head.
V.—The valve opening outwards at the upper end of the pump head.
W.—Winch.
Y.—Three-way communication to atmosphere, or auxiliary pump.
Z.—Return tube for mercury.

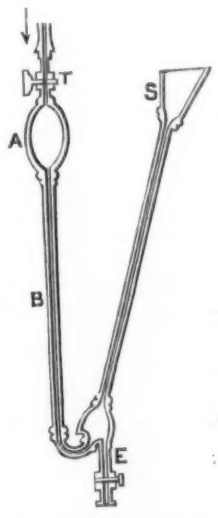


FIG. 3.—BAADER'S PUMP. (FIRST FORM).

Sixty years elapsed before a second form of mercurial pump was devised, by Dr. Joseph Baader,* who, about 1784, devised the pump depicted in fig. 3. This pump consisted of a hollow

* André. Specification of Patent, No. 4,654, 1881. Electric Illumination, vol. i., p. 665.
† See *Electrician*, xix., 159, July, 1887.
‡ Kravogl. "Carl's Repertorium," iii., 362, 1868. See also Deschanel's "Natural Philosophy" (1881), i., 190. Similarly a mercury packing was employed in a water pump by Haskins, and is described in Desagulier's Course of Experimental Philosophy (1763), vol. ii., p. 491.
§ Regnault. "Rélation des Expériences," ii., 553.
‖ Swedenborg. "Miscellanea observata circa res naturales." Lipsiæ. 1722. Fig. 11.
¶ Swedenborg. "Miscellanea observata circa res naturales, el praesertim circa mineralia, ignem, et montium strata." Lipsiæ, 1722, p. 101. See also "Gren's Journal," vol. iv., p. 407

* Baader. See Hübner's "Physikalisches Taschenbuch." Salzburg, 1784, p. 630, referred to in Gehler's "Physikalisches Wörterbuch," vi., p. 602 (Ed. 1831).

ellipsoidal vessel, A, at the summit of the barometric column, B, terminating above in a passage containing a three-way tap below it, bent round into a chamber with an outlet-tap, and having a second rigid tube, inclined at an angle, ending above in a funnel-shaped vessel to receive the mercury. To work this pump, the bottom tap was closed, and the three-way tap was turned so as to make the pump head, A, communicate with the outer air. Mercury was then poured into S until A was filled; the three-way tap was then turned to cut off communication with the air, and to connect A with the receiver or other vessel to be exhausted. The bottom tap was then opened, and a portion of the mercury permitted to run out until the top of the barometric column was below A, producing a partial vacuum in the pump head and the receiver. The lower tap was then closed, the three-way tap returned to its former position, and the mercury which had flowed out of the pump was poured again into S, and the operation repeated. It will be obvious that this operation is equivalent to raising and lowering the supply vessel, as in the pumps of Geissler and Toepler, and their prototype of Swedenborg. Baader had a curious history. In 1784, when this pump was devised, he was studying in Vienna.

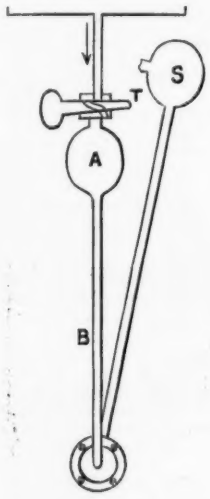


FIG. 4.—BAADER'S PUMP (SECOND FORM).

He afterwards went to Göttingen, thence to Edinburgh, where he took the degree of Doctor of Medicine; but he quitted the medical profession for that of mining, and was afterwards connected with an iron works at Wigan. Gehler states that Baader abandoned his first form of pump in favour of a second,† shown in fig. 4 which differs from fig. 3 in having the supply vessel capable of being raised and lowered, not by a flexible tube, but by turning it about on a joint provided at the meeting point of the barometric tube and the supply tube.

A very finely constructed pump, on Baader's principle, exists in the collection of apparatus in the physical laboratory of University College, London, having apparently been acquired in April, 1828. There is no maker's name or date on the apparatus, but it belongs to, and is catalogued as being "the Torricellian part" of a fine double-barrelled air pump (price £100) by the famous instrument maker John Cuthbertson, of Amsterdam and London. It is shown in fig. 5. The exhaust-pipe of brass leads from the three-way tap at the top to a union joint below the plate of the mechanical pump, so that the exhaustion having been carried in the ordinary way to a certain point, it should be completed by using the Torricellian part. The apparatus is mounted on a massive tripod of mahogany; the fittings of the taps are of metal (steel or iron); the height from floor to the top of the exit funnel is just under two metres; the height from the bottom tap to the bottom of the pump-head is just over one metre. The barometric tube, B, is of glass, as is also the supply tube. The pump-head is a substantial glass vessel, almost exactly one metre in external circumference, hence it would require about 400 lbs. of mercury to work the pump. Prof. Carey-Foster states that it is believed to have been acquired by Dr. Lardner's direction; he has no knowledge of its having been used. I have not been able to discover in any of Cuthbertson's pamphlets or price catalogues now extant any reference to this part of the apparatus.

A pump on the same principle was patented in 1881 by Mr. Rankin Kennedy. It is described later.

† Baader. See Hübner's "Taschenbuch," cited above; referred to, with figure, in Gren's "Journal der Physik," ii., p. 326; see also Hindenburg. "De Antlia Baaderiana," 4to Leipzig, 1787, referred to in Young's "Lectures on Natural Philosophy." A quarto volume published at Bayreuth, in 1797, under the title "Theorie der Pumpen," is possibly by the same Baader.

In 1787 C. F. Hindenburg* described the pump shown in fig. 6, closely resembling Baader's, but having a piston and cylinder for the purpose of driving the mercury up and down in the barometric tube.

FIG. 5.—PUMP IN UNIVERSITY COLLEGE.

Cazalet,† of Bordeaux, states, in 1798, that he has constructed an apparatus like Hindenburg's, of glass and iron, and that he has succeeded with it in getting an exhaustion of one millionth of

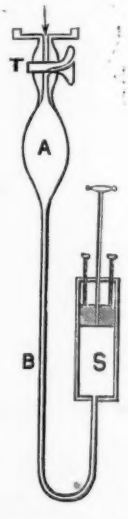


FIG. 6.—HINDENBURG'S PUMP.

an atmosphere; how he measured this does not appear. A similar kind of pump appears to have been used by Michel.‡

In 1804 A. N. Edelcrantz§ published a "Description of a mercurial

* Hindenburg. See Gehler's "Physikalishes Wörterbuch," vi., p. 603 (1831 edition), which refers to Hindenburg, "Antliæ novæ hydraulico-pneumaticæ mechanismus et descriptio." Leipzig. 4to. 1787. Young mentions also Hindenburg, "De Antlia Baaderiana." Leipzig. 4to. 1787; and to Hindenburg "De Antlia Nova," Leipzig. 4to. 1789.

† Cazalet. "Gren's Journal," i., p. 478.

‡ Michel. See "Gren's Journal," ii., p. 129.

§ Edelcrantz. "Nicholson's Journal," vii., p. 188.

air pump of unlimited exhausting power, with a wooden piston." This pump (fig. 7), which appears to have been independently conceived, is on the same lines as Hindenburg's, but with superior mechanical arrangements. The three-way tap, instead of being bored diagonally toward the handle, is bored toward the outer end, as in the modern Geissler pumps, and the wooden piston (P) is moved in its stout wooden casing by a rack and pinion motion.

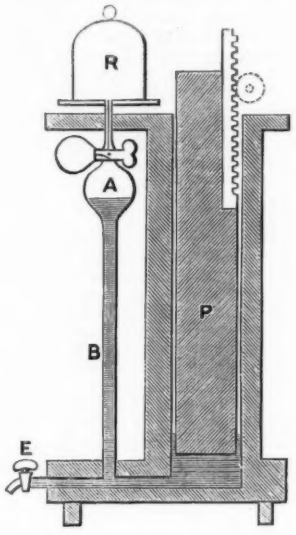


FIG. 7.—EDELCRANTZ'S PUMP.

Some years after this "Nicholson's Journal" contains a description of Traill's* apparatus, which has already been mentioned. It drew a further communication from R. Bancks, instrument maker in the Strand, that he had constructed similar apparatus for Mr. Children at a prior date.

In 1824, Joseph H. Patten† wrote an "Account of a New Air-pump," which, like those of Hindenburg and Edelcrantz, had a piston to raise and lower the mercury, but which in another point more nearly resembled the original pump of Swedenborg. The pump-head consisted of a wide-mouthed glass globe, on the top of which was fixed a flat metal plate with a raised rim. In the centre of this was adopted a metal pipe, having a valve opening downwards below it. This valve, a mere metal plug, was held upon a stiff wire which entered the tube above, and was continued downward to the summit of the barometric tube, where it ended in a ball float. When the mercury rose it lifted the ball and closed the valve, and maintained it closed till it once more fell. The air in the pump-head was expelled through a separate valve, opening outward in another part of the plate. Patten suggested that instead of the stiff wire, ball, and valve, the exhaust tube should be prolonged downwards to near the bottom of the globe. The publication of this description drew from Prof. J. F. Dana‡ some remarks suggesting, apparently without knowledge of prior inventors, that it would be preferable to use a three-way tap. To this Patten replied in a later issue in a strongly personal vein.

(To be continued.)

SCHANSCHIEFF'S PORTABLE PRIMARY BATTERY.§

AN eminent authority once said—"Science never shines with a sublimer lustre than when exerted in the cause of humanity." Where, I would ask, is to be found an occupation attended by so much risk to personal safety as that of coal-mining? Whoever promotes the miners' security is justly entitled to the gratitude of the community. Let us therefore do our best to obtain this end.

You are doubtless aware that Sir Humphrey Davy, who introduced the familiar "safety lamp," also discovered the electric light, and I may remark that a primary battery was its first generator. We are here this evening to consider whether recent discoveries in the electric light, and batteries therefor, may not only provide absolute or perfect security to our miners, which the Davy lamp does not ensure, but furnish a better luminant also. The inference I have drawn from past discussions as to how the electric light shall be installed is favourable to the use of small portable batteries. To my mind it is an indispensable condition, for such a source of light-giving power can be made absolutely free from danger, convenient, cheap, and thoroughly reliable. Two kinds of portable batteries are known to us—the *primary* battery and the *secondary* battery. The first produces electric energy when zinc, in the presence of another element, is acted upon by a chemical compound, and the second derives its formation and power from some extraneous electric generator, taking say ten to twelve hours for its renewal of energy; but the primary of my own invention could be entirely refitted if necessary in half as many minutes, or easily recharged with its liquid excitant in less than fifteen seconds. My battery may be left idle for years without deterioration; but can this be said of any secondary battery? It has been said that, weight for weight, the amount of electrical energy stored in a primary battery was larger than that stored in the secondary battery, and therefore it would yield as much light as the secondary battery. Surely if the primary possessed more stored energy than the secondary, it would yield an equal light for a longer period, and I believe my own batteries would be found to do the work more economically during twelve months' comparative trial than the best secondary battery in the market at the present time. Experience has shown me that small secondary batteries are much more troublesome than large ones, and in case of derangement far more difficult to renovate than primary batteries. However, as I have no desire to underrate the good work of other battery promoters and inventors, I will at once describe and illustrate to you my own invention. The elements I employ are carbon and zinc, and the only excitant a mercurial solution of my own discovery; hence it is a single fluid battery—that is, a battery containing one kind of liquid only, and thereby dispensing with the necessity for any porous medium which wastes energy by producing resistance. Its shape, size, and number of cells, as also the position of the lamp, can be arranged as required. Some of my exploring or miners' portable batteries are reversible—that is to say, they are inverted to throw them in or out of action, while others are electrically disconnected by lifting the plates out of the liquid; but either form can be hung or stood up. By merely depressing a screw, or turning a lever, they are made liquid tight, and yet a simple device permits of the carbons and zinc elements being adjusted to obtain more or less current as desired. All connections are enclosed, consequently no *sparking* can possibly occur outside the appliances. The batteries are opened and closed thus . . . . . , and the elements held out of the solution in this manner [illustrating]. My mining batteries weigh, when fully charged, about 3¾ to 5 lbs., that which consists of three cells, and measures outside 4 inches in diameter, and 4 inches deep. Each cell contains 5 (five) fluid ozs. of liquid, which in consuming together three-eights of a lb. of zinc in 48 hours, furnishes a light of nearly 2 (two) candle-power. This is, I think, the smallest and lightest practical miner's lamp of the kind ever made for the time it will work efficiently. It is guaranteed to burn from 8 to 9 hours. The light is more than four times more powerful than that of the Clanny oil lamp, and trustworthy experts have found it to be by far the cheapest electric miner's lamp of any they have ever tested, and its working cost is five-eights of a penny per shift, or 3⅝d. per week. The 4½ lb. battery comprises four cells, each taking 5 fluid ozs. of mercurial solution, and at a total cost of seven-eights of a penny per one shift of about 9 hours' duration, gives a light ranging between two and three candle-power. The larger size 4-cell battery, measuring 5 inches in diameter and 6 inches deep, with 24 ozs. of solution, will burn from 11 to 12 hours at a cost of about one penny. But without further comment I will explain the foregoing economical result.

The solution can be supplied at 4s. a gallon, and 3s. 7d. will be allowed for the same quantity of the spent liquid with its solid residue and free mercury precipitated by the action of the cells. A four-cell battery requires three-fourths of one gallon of solution for a period of 48 hours or 6 shifts, and, I must tell you, the mean result of many tests of the 4-cell lamps have shown the consumption of zinc to be one-twelfth of a pound per shift, or ½ lb. during 48 hours of work. Hence:—

	s.	d.
Three-fourths of a gallon of solution at 4s. per gallon, say ... ... =	3	0
½ lb. of zinc at 2½d. per lb. ... ... =	0	1½
Total	3	1½
Less the value allowed for three-fourths of used solution, &c., at 3s. 7d. per gallon ... =	2	8½
	0	5

Actual cost of working 6 shifts of 8 hours with 4-cell lamp = 5d. (fivepence).

Or the actual cost for one shift seven-eighths of a penny. A 3-cell battery requires 90 ozs., or a little over ¼ gallon of solution for 6 shifts, and the consumption of zinc for the same period is three-eighths of a lb. Hence:—

	s.	d.
90 ozs. of solution at 4s. ... ... =	2	3
Three-eighths of lb. of zinc at 2½d. ... =	0	1
	2	4
Less value allowed for 90 ozs. spent solution at 3s. 7d.	2	0½
	0	3½

* Traill. "Nicholson's Journal," xxi., pp. 63 and 161.

† Patten. "Silliman's Journal," viii., p. 144, 1824, and ix., p. 92, 1825. An almost identical apparatus, called an "oil air-pump," by Sadler, is described by Gehler, vi., p. 606.

‡ Dana. "Silliman's Journal," viii. p. 275.

§ A paper read by Mr. A. Schanschieff before the South Wales Institute of Engineers at Cardiff, November 24th, 1887.

Actual cost of working 6 shifts for 8 hours with 3-cell lamp is = 3¾d., or the actual cost for one shift is five-eighths of a penny.

This result must seem to you incredible, but the fact is I get back my mercury either free, or amalgamated with particles of zinc, from which it can readily and inexpensively be separated, and this, with the spent liquid, can be used again in the manufacture of new solution. So you see we have at last obtained a battery which yields valuable by-products. I cannot do better than read to you Sir William Thomson's report to me, dated October 27th, 1877. It runs thus:—

"Mr. Schanschieff's battery is, in some of the qualities of chief importance for practical use, superior to all other voltaic batteries, primary or secondary, hitherto known.

"It is a one-fluid battery of high electromotive force (1·39 volts), of very low resistance (·15 of an ohm for 10 square inches of zinc surface), and of remarkable constancy. It is highly satisfactory as to freedom from sudden variations—a most valuable quality in a battery designed for lighting purposes.

"In respect to polarisation, I consider Mr. Schanschieff's battery remarkably perfect, certainly much better than any other single-fluid battery hitherto invented. The results I obtained during a series of varied experiments on open cells set up in my laboratory, and subjected to very severe treatment as to the amount of current taken from them, were very remarkable, as showing almost perfect freedom from polarisation.

"It is perfectly free from evolutions of gas, or fumes, or smell.

"The solution in or out of action is entirely free from all liability to explosion or combustion, or ignition. The fact that the battery is brought into or out of action by immersing the plates into or removing them out of the solution avoids most effectually all chance of sparking, and as there is no other make-break connections in any part of the lamp, all risk of explosion in a fiery mine is avoided.

"The only substance consumed in its working is zinc. The mercury used in the solution is not lost, and is easily reinstated in proper solution for fresh use.

"It is vastly less troublesome, and I believe it will be found to be less expensive for ordinary use than any of the two-fluid batteries hitherto known.

"No single-fluid primary battery approaches it in the fundamental qualities of constancy and working efficiency in proportion to bulk, or number of cells required, or weight or consumption of zinc.

"For miners' lamps, and for many other purposes in which the quantity of current used is so moderate that the mere cost of the zinc is not too serious, I believe it will be found more convenient, and less expensive, than a secondary battery charged by a dynamo.

"I found that the cost of lighting for materials consumed in the 4-cell miners' lamp which I have tested during a shift or period of eight hours is one penny. It is thoroughly durable, and may be kept for months or years charged and ready for use without any loss of zinc or solution, and without any damage to any part of the cells or fittings.

"It may with equal economy of its work be used intermittently for a few minutes or hours at a time at intervals during months or years, or worked without stopping till its solution is exhausted.

"After being run down it can be charged again in half a minute or a minute, unlike a secondary battery, which requires many hours to charge and a dynamo to effect the charge.

"I consider Mr. Schanschieff's battery to be a great advance on any previously known primary battery, and I believe it likely to find a wide and varied application, and as a laboratory battery capable of giving a large current and maintaining it for several hours, it will certainly be extremely useful.

"(Signed) WILLIAM THOMSON.

"The University, Glasgow,
"*October 27th*, 1887."

During one series of tests Sir William obtained the following results:—

Time.	Potential volts.	Current amperes.	Resistance of cell in legal ohms.	Total ampère-hours run.	Temperature. Air.	Temperature. Cell.	Remarks.
10.20 a.m.	1·33	3·91	0·08	0	17·2° C.	17·2° C.	
11.0 „	1·33	3·91	0·07	2·61	17·2	19·0	
12 noon.	1·31	3·87	0·08	6·48	18·0	21·6	
1.0 p.m.	1·31	3·71	0·09	10·19	19·0	24·1	
2.0 „	1·29	3·61	0·09	13·80	20·0	24·4	
3.0 „	1·31	3·80	0·08	17·60	20·0	25·5	
4.0 „	1·28	3·50	0·07	21·10	20·0	26·7	Liquid stirred up before reading.
5.0 „	1·28	3·50	0·06	24·60	20·3	27·2	
6.0 „	1·30	3·30	0·06	27·90	20·0	27·2	
7.0 „	1·25	2·99	0·06	30·89	19·4	26·6	After burning one shift.
8.0 „	1·17	2·12	0·06	33·01	19·0	26·1	
8.20 p.m.	1·06	2·06	0·07	33·69*	19·0	26·1	

* Total ampère hours per sq. centimetre of zinc surface = 0·31, being equivalent to about 2 ampères per sq. inch zinc surface.

Such evidence as this from so great an authority as Sir William Thomson is, I submit worthy of marked attention. Kindly permit me to claim kind indulgence for a little longer. In lighting a mine I propose to establish a suitable waste tank in the lamp room; on the colliers retiring from their labour the contents of their battery can be readily emptied at leisure, and the lamp speedily recharged ready for use at any moment. By allowing the liquid to stand insoluble matter will settle on the bottom of the tank. The liquid can be drawn off periodically, and the solid matter with the free mercury collected. Should the proprietors of any mine prefer making my solution for themselves then the spent solution and other valuable substances found in the tank could be readily and cheaply reconverted into fresh and good solution on the spot by my process of manufacture.

Gentlemen, in my concluding remarks I am prompted to remind you that a new industry, or even device, which has for its object greater protection against the most shocking accidents our fellow men are exposed to, seldom finds general acceptance at first. When Sir Humphrey Davy introduced his safety lamp he met with many opponents, one of whom arrogantly asserted, "that perfect security against explosions never could be obtained by human intellect!" Who can estimate the number of horrible catastrophes Davy's simple lamp has averted since 1815? Yet withal, it will assuredly give way to the electric lamp as a better and safer light.

By employing the electric lamp, I venture to say that no anxiety need be felt by the user from "blowers," floating coal dust, or even fracture of the lamp itself, in the midst of inflammable gas, because the lamp is within a very strong glass cover, the mouth of which is screwed down upon India-rubber or other elastic substance, thus effectually sealing the lamp globe from outside gases. But, finally, let me invite your most earnest attention to this point. The fragile incandescent filament is, as you know, in a very high vacuum, and when the globe containing it is broken the whole *instantly* flies into minute fragments under the outward pressure. Now I am inclined to think, and I shall certainly try the experiment, that as all matter requires time to attain its temperature of ignition before the surrounding explosive gas could reach its point of ignition the filament would be broken and all danger cut off.

Here is another of my batteries fitted with a "fire-damp detector." If an explosive mixture is suspected, the lamp is switched out of circuit, and the platinum loop inserted in its place. When all is safe the platinum feebly glows, but should the space within the gauze be filled with explosive gas the glowing platinum rises to a white heat, and the mixture gently explodes. By the aid of an India-rubber syphon I, after exhausting the ball of air, suck into it the gas it is desired to test, and taking the sample of gas to a safe place, inject it into the gauze enclosure while the platinum loop is just red. I will give you an illustration of this fire-damp detector.

Having thus explained the system and working of my miner's lamp, I believe that all impartial critics must admit that I have succeeded in producing a most practicable electric miner's lamp, which, on the grounds of simplicity in construction, of working efficiency, and economy, will meet all the requirements of the long looked for portable electric safety miner's lamp.

METALLIC CIRCUITS FOR TELEPHONE LINES.

By A. R. BENNETT.

THE running of metallic circuits for telephone trunk lines is a matter which cannot be lost sight of by any telephone company, whatever system it may adopt, metallic circuits everywhere, or single wires to the subscribers' offices and double wires between distant towns. Even when overhearing between wire and wire is considered admissible, it is not always possible to keep away from Post Office and railway wires when running from town to town, in which case the telegraphic induction compels resort being had to metallic circuits. When several metallic loops are run on the same poles, they must be arranged in respect to each other so that no overhearing shall take place between them. This end has been accomplished by the method of making the two wires of each metallic loop perform a circuit round each other every few poles. (See *Journal of Society of Telegraph-Engineers and Electricians*, January, 1883.) But while answering its purpose admirably, indeed perfectly, in an electrical sense, the plan—generally known as the *twist*—has several drawbacks which militate gravely against its universal employment, especially on crowded routes. The objections to the twist system are as follows:—(1) It is more costly to erect and maintain than straight wires, owing to the greater care necessary in all respects. (2) The necessary dropping from an upper arm on one pole to a lower on the next, and rising from a lower to an upper, increases the liability to breakages, for it is equiva-

lent to using supports of different heights, which, again, is as severe on the wire as longer spans on the straight would be, for, in considering the strain, the span must be taken as extended beyond the lower support to a point equal in height to the taller one, and the strain is increased proportionally to the length of the increase. With copper wire this is not negligible, especially as, to avoid contacts, wires run on the twist are frequently pulled up tighter than those run straight, (3) It is unsightly; from a distance the wires appear crossed and out of regulation. (4) With the greatest care that can be exercised, contacts are more numerous unless the wires are kept farther apart than would be necessary on the straight, which means reduction in the capacity of the poles. (5) It is difficult to alter an established route of twisted wires without interfering with the traffic. (6) Linemen cannot detect contacts readily. At a little distance, twisted wires always look in contact, and the man has to walk under, or nearly under them, and watch them open out from pole to pole before he can be sure that it is in appearance only. When poles are erected by the side of a good road this makes but little difference, for the man can then walk under the line and sustained watchfulness is all that is required. But often poles are erected on the tops of embankments, in rough ground, covered with furze, bushes, and trees, sometimes within the road limits, sometimes on private property, or the wrong side of fences, hedges, walls, or ditches; or the poles may cross to the other side of a canal, where no bridge exists; so that the task of walking under the wires becomes difficult, and a fault is apt to be missed, especially in foggy weather, or, if not missed, its removal is almost certain to be longer delayed than would be the case with straight wires.

In the ELECTRICAL REVIEW of December 20th, 1884, appeared a suggestion that the twisting of metallic loops might be dispensed with, and simple crossing of straight-run wires every few poles substituted. Having a metallic loop about 19 miles long to run shortly afterwards, close, and parallel to a very heavy route of telegraph wires, the author determined to give this plan a trial. The wires were run straight, terminated every 12 poles and crossed with G.P. The result was quite satisfactory. The telegraph induction, which was frequently strong enough to prevent communication on a single wire, was entirely killed, and the silence between the loop and some long single telephone lines on the same poles was complete. The reason for this is easily understood, since the crossing of the loop every twelve poles brought the two component wires alternately near the distributing influences, and made their mean distance from the induction the same. Other metallic loops on the same plan were erected subsequently, and all successfully, until it became necessary to run several on the same route, and not all on the same arms. Then a difficulty, not anticipated in the ELECTRICAL REVIEW article—which dealt only with induction between loops and single wires, and not between two or more loops—had to be overcome. Any number of metallic loops crossed at the same points, may be placed alongside each other on a plane, and perfect silence will reign between them; but if, when the top arm of a route is filled, other loops are run below them, the crossing distances must be halved, doubled, or otherwise varied in order to prevent overhearing. This will readily be understood by an inspection of Fig. 1.

When the two crossed metallic loops A, B, are on the same plane, a current circling in one will obviously produce no apparent effect in the other, for the component wires of A, in which the current is circling, may each be regarded as a single wire in respect to its effect on B. In each of B's wires the currents in A induce currents opposite in direction to themselves, and since the mean distance between A and B's wires is the same, the induced currents are equal in strength and, meeting in the telephones or translators, neutralise each other. The outside arrows in B represent the currents induced by the currents in A travelling from left to right, and the inside arrows those induced by the currents from right to left.

But if B is placed above A instead of on the same plane, the effect is totally different. We then have practically a parallelogram of wire imposed on another of the same dimensions, an arrangement equivalent to the primary and secondary of an induction coil.

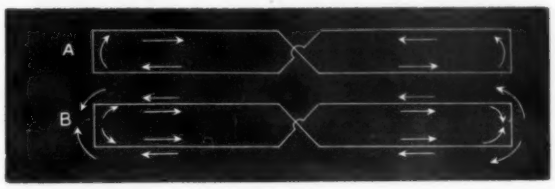


FIG. 1.

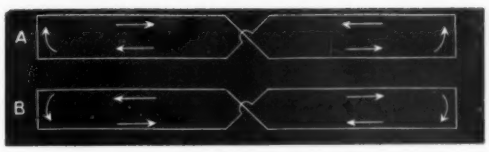


FIG. 2.

The circling currents in A (fig. 2) now induces a corresponding one in B, and the overhearing becomes as bad as between two single wires. To remedy this we must either cross A midway between the crossing of B (fig. 3) or eliminate the existing cross (fig. 4). A

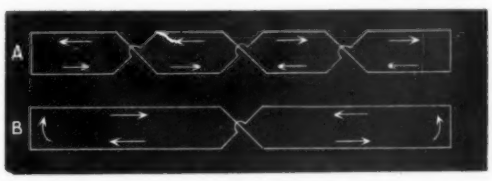


FIG. 3.

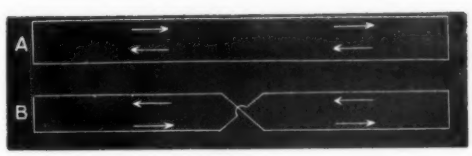


FIG. 4.

current circling in B (fig. 3) induces currents of equal and opposite strengths in A, and a current circling in A (fig. 4) induces equal and opposite effects in B, the result being silence between the loops. Another neutral position is shown in fig. 5, B being the inducing loop. The effect is precisely the same when one loop

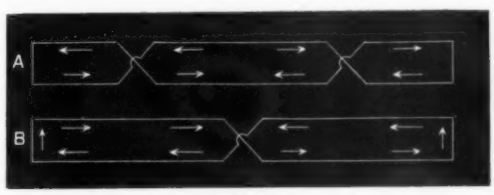


FIG. 5.

is placed inside another, as in fig. 6. For the sake of clearness the figures are made to represent complete loops; in practice, a short line is generally made up of several, and a long line of many, such sections. In running loops on different arms on the same poles, it is consequently necessary to break joint, as it were, with the crossings. In arranging the crossings on a

route between two towns, care should be taken to have an equal number of sections, for an odd section, if a long one, at either end, will cause trouble with single wires on the same poles, except the one on the saddle, or in the vicinity. The best plan is to select a crossing place as near midway—counting by poles—as possible

FIG. 6.

between the two towns and so divide the loops on the top arm into halves. Then those on the second arm may be divided into quarters; those on the third into eighths; those on the fourth into sixteenths, &c. For instance, if a route is composed of 256 poles, it may be divided into sections as follows, running six wires, equal to three loops on each arm, as is often done in telephone work.

Top	arm	1	section	of 256	spans.
Second	„	2	sections	„ 128	„
Third	„	4	„	„ 64	„
Fourth	„	8	„	„ 32	„
Fifth	„	16	„	„ 16	„
Sixth	„	32	„	„ 8	„
Seventh	„	64	„	„ 4	„
Eighth	„	128	„	„ 2	„
Ninth	„	256	„	„ 1	„

This arrangement will yield 27 loops, as many as are ever likely to be required on the same poles, but it by no means exhausts the possible variations. All these 27 loops will be silent in respect to each other; but the three loops of one section of 256 spans, *i.e.*, the whole length of the route, would not be silent in respect to a single wire carried on the same or adjoining poles, although all the others would be. One of them—the middle of the three—would also be silent in respect to a single wire carried on the saddle. Uncrossed loops are therefore only admissible on a route not subject to disturbance from single wires, telephonic or telegraphic. When starting a route with a limited number of loops it is well, for the sake of simplicity and economy, to make the crossing places as few as possible, crossing once on the top arm, thrice on the second, seven times on the third, &c. This generally suffices, even in the presence of considerable telegraphic induction, but when such disturbance is very great, and the telegraph line is not approximately parallel the whole distance, more frequent crossings may be necessary. When a busy telegraph route comes near the telephonic and leaves it again after running parallel some distance, the crossings may advantageously be made more frequent in the presence of the disturbance, and an odd section must not be left opposite the telegraph wires. A little care is likewise necessary in arranging local wires, either single or double, which run along the main poles for short distances. It is, of course, known before such wires are erected how far they are to run on the main poles, and it is easy to divide them so as to secure silence. The system calls for a little thought and ingenuity on the part of the engineer; but a case has not yet arisen which could not be satisfactorily dealt with. It may be objected that as the crossings count per number of poles, variations in length of the spans will cause the sections to be unequal. This is so, but it has no effect on loops running on the same arm, and it affects those on different arms but slightly, for the spans on a main route are generally approximately equal, while it takes a good deal of variation to set up overhearing. Besides, the engineer can allow for the occurrence of unusually long or short spans here and there, by shifting a crossing backwards or forwards one or two poles. The objection that G. P. covered wire decays rapidly when exposed to the weather, particularly when in contact with creosoted poles, appeared a grave one at first, but the method adopted by the author of making the crossings (Figs. 7, 8, and 9) entirely overcomes this. The G.P. leads are carried from insulator to insulator without touching the pole or each other, the lower one dipping under the upper. There is plenty of room for this, and the length of G.P. being short and the wire

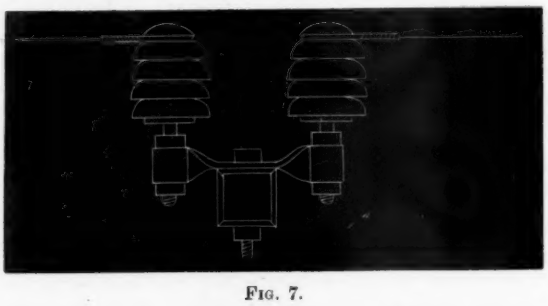


FIG. 7.

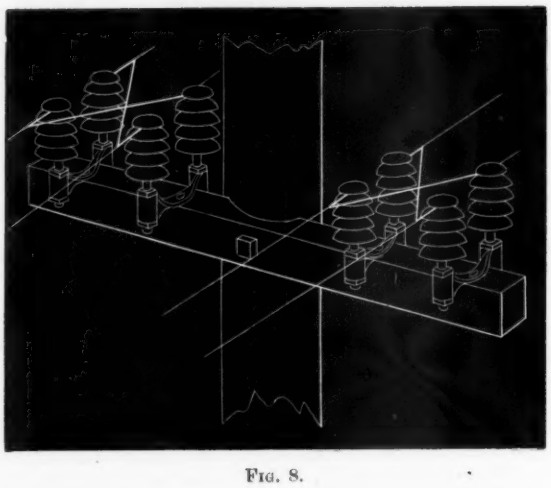


FIG. 8.

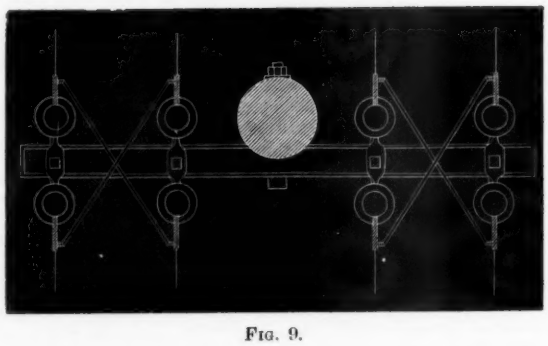


FIG. 9.

stiff, there is no difficulty in keeping them clear, even in stormy weather. Under these circumstances, decay of the G.P. is not of much moment, but it might be postponed indefinitely by using G.P. covered with lead or, preferably, with an alloy of lead and tin. This crossing system has been extensively employed in Scotland and Cumberland for about two and a half years by the National Telephone Company, and is found to secure a perfectly satisfactory service, while being easier and cheaper to erect and maintain than wires run on the twist.

Manchester Association of Engineers.—On Saturday evening last Mr. J. R. Williamson, M.S.T.E., read a paper to the above association at the Grand Hotel, Aytoun Street, on "Electric Lighting from Central Stations," Mr. W. H. Bailey, president, in the chair. The paper was illustrated by numerous drawings and a few experiments.

ELECTRICAL HAULAGE TESTS.

In those collieries in which for any reason steam engines below ground are objectionable, there is a good field for the employment of electric motors on the engine planes. At the request of the manager of Walker Colliery, the late Mr. Matthew Heckels, an experiment of electric haulage was made at the Newcastle Exhibition, and some of the results are given below. After some consideration it was decided to employ worm gearing between the motor and driving sheave, and the gearing was designed for a working traction of 250 lbs. Through Mr. Heckels's illness the construction of the line by the Colliery Company was given up, and the gearing was applied to a line requiring a traction of about 12 cwts. A 15-H.P. motor was therefore supplied instead of a 5-H.P. motor. This change occasioned some delay; in the meanwhile other arrangements had to be made for working the lines to which it was intended to apply the motor, and as a result a new line was made, on which all the available tubs were placed, with the result that the load was too light for the motor and too heavy for the gearing. The experiments, however, showed that with a little more attention to details, electrical haulage might be made a decided success underground, with an efficiency twice as great as that obtained with hauling engines driven by compressed air.

The motor was constructed by Messrs. Immisch and Co., of London, by whom it was lent to the council of the exhibition. It was reversed by the employment of two sets of brushes on a rocking frame. The motor was started with a number of iron resistance coils in circuit, which were rapidly switched out as the speed increased. With this arrangement the tubs were under perfect control, and a very sudden stop could be effected by reversing the motor with the resistances in circuit.

The line was 100 yards long, 2 feet guage, and laid with 28 lbs. rails, the sleepers being at intervals of 3 feet., just as in an underground road. The rope was 1½ inches in circumference, and was carried round 5 feet sheaves at either end of the line. The sheave at the lower end had keyed to its shaft a worm wheel, which geared into a worm coupled to the motor shaft by a flexible coupling. The gearing ran in an oil bath. The worm was single-threaded, and the wheel had 75 teeth; thus the motor made 75 revolutions for one of the driving sheave; and 75 revolutions of the motor corresponded to a movement of the rope of 15·75 feet, about.

The worm was cut from cast steel, and the wheel was cast in iron. This gearing, however, was by no means satisfactory, the friction was considerable, and caused serious heating of the worm and wheel. The worm pitted a little, though it stood the running fairly well, but the wheel wore away rapidly. The efficiency of such gearing is not more than about 40 per cent., as will be seen from the figures given.

The tubs were seven in number, and were filled with scrap iron and loose ballast, making a total rolling load of 5 tons, 6 cwt. 1 qr. 7 lbs.

The motor was designed to run at 1,000 revs. per minute, and to give out 15 brake H.P., the electrical quantities being 300 volts and 50 ampères. Since the motor was too powerful for the work, however, the speed and current varied as shown in the table of observations made during the test.

The tractive force required to move the loaded tubs and the rope varied between 312 lbs. and 704 lbs. This heavy traction is to be explained by the surface of the rails being in a very bad condition. The tension in the rope was also considerable, but was necessary to prevent surging, since the rope only made little more than one half a turn round the driving sheave.

The road had a variable gradient, but rose roughly 1 in 75 on an average, though at places, judging by the tractive force rising to 700 lbs., the gradient must have been a good deal heavier.

The following tabulated figures will show in a convenient manner the results attained.

The following test was made by Mr. M. Walton Brown, representing the Haulage Committee, assisted by Prof. Garnett and Mr. W. B. Sisling; Messrs. Immisch & Co. being represented by Mr. Albion T. Snell.

Average work done on the rope on the up grade was

$$\text{1st part } \frac{442 \times 268}{33{,}000} = 4{\cdot}85 \text{ H.P.}$$

$$\text{2nd part } \frac{504 \times 268}{33{,}000} = 5{\cdot}5 \text{ H.P.}$$

$$\text{3rd part } \frac{704 \times 268}{33{,}000} = 7{\cdot}7 \text{ H.P.}$$

TABULATED RESULTS OF TEST.

Work done.	Gradient.	Volts.	Amp.	Speed of motor.	E.H.P. put in motor.	Time taken for tubs to travel 100 feet in centre of track.	Speed of tubs during this time in miles per hour.	Traction as measured by dynamometer.
7 loaded tubs	Up	280	31·5	1,500	11·8			
,,	Up	280	31·5	1,300 ?	11·8			
,,	Up	301	28 / 32	1,520	11·4 / 12·9	21 seconds	3·25 miles	*Average* 442 lbs. at first portion of *up* grade
,,	Up	280	28	1,360	10·5			*Average* 504 lbs. in centre of *up* grade
,,	Up	280	27	1,380	10·2			
,,	Up	280	30	not taken	11·3	23 seconds	3 miles	*Average* 704 lbs. at the end of *up* grade
,,	Up readings taken	287	35	1,100	13·5	Start		
,,	at different parts	287	33	1,200	12·7	21 seconds	3·25 miles	
,,	of the line	294	30	1,300	11·8			
,,		294	26	1,500	10·3	Finish		
,,	Down	294	23	1,760	9·1			
,,	Down	291	25	1,740	9·8	17 seconds	4 miles	Average throughout the *downward* grade
,,	Down	308	24	not taken	9·9			
,,	Down readings taken	280	28	1,150	10·6	Start		
,,	at different parts	308	21·5	not taken	8·9	17 seconds	4 miles	312 lbs.
,,	of the line	280	23	1,780	8·65	Finish		
,,	Down readings taken	280	27	1,300	10·2	Start		
,,	at different parts	287	26	1,400	10	17 seconds	4 miles	
,,	of the line	301	23	1,600	9·4			
,,		308	23	1,750	9·6	Finish		
Rope running without tubs	Down	217	15·75	1,720	4·5			
,,	Up	213·5	15	1,720	4·3			
,,	Up	213·5	17 ?	1,620	5·25			
,,	Up	150	14·5	1,300	2·93			
,,	Up	145	13·5	1,250	2·63			
,,	Up	137	13·5	1,140	2·48			
Motor running with worm out	...	90 to 93	6	1,350	·725 to ·75			

Average work done on the rope on the down grade was

$$\frac{312 \times 352}{33{,}000} = 3{\cdot}34 \text{ H.P.}$$

The weak point about the gearing undoubtedly lay in the very small pitch of the worm wheel and screw. The screw had only a single thread, and as the worm wheel was 30 inches in diameter, with 75 teeth upon it, this corresponded to a pitch of only $1\frac{1}{4}$ inches. The driving sheave was 60 inches in diameter: and, therefore, when the traction on the rope, as measured by the dynamometer, was 504 lbs., the pressure between the screw thread and the worm wheel must have exceeded 1,008 lbs. on account of the obliquity of the thread. Taking the effective diameter of the screw as 4 inches, and making 1,370 revolutions per minute, the relative velocity of the rubbing surfaces was 1,435 feet per minute. If we take the electrical horse power taken up by the motor as 12, when the tubs were running up hill and the traction amounted to 504 lbs., and if we suppose the efficiency of the motor to be 90 per cent., which is probably rather above the mark, as it was running with less than its full load, and at 37 per cent. above its normal speed, we have for the brake H.P. 10·8. The actual H.P. developed on the rope amounted to 4·36, leaving 6·44 H.P. absorbed in the friction of the gearing. This would correspond to a co-efficient of friction between the screw and worm wheel of nearly $\frac{6{\cdot}44 \times 33{,}300}{1{,}008 \times 1{,}435}$ or ·146.

Taking the run down hill in the same way the co-efficient of friction appears to be ·151, but as the speed of the motor was much greater, and the whole power developed less, there must have been a greater percentage absorbed in the motor, so that the results are sufficiently consistent.

As the cast iron worm wheel wore very rapidly, and the oil became very gritty, it is probable that the co-efficient of friction was not much less than ·14.

Had a worm been employed of 6 inches pitch, as recommended by Reckenzaun, the loss by friction would have been reduced to about one-fourth of the actual loss experienced, and the efficiency of the system would then have been 66 per cent. This could have been effected by using a 3-feet sheave and a 4-feet worm wheel, doubling the speed of the tubs, and running about 10 tubs instead of seven.

At the time the measurements were taken, the gearing had been running some time, and the oil in the bath was thoroughly impregnated with finely-divided iron from the cast iron worm wheel. In future experiments it would be well to employ a steel worm wheel, and great care should be taken to ensure that the casting is perfectly free from sand before it is placed in the oil bath.

NEW MUNICIPAL BUILDINGS, GLASGOW.

THE Corporation of the City of Glasgow is prepared to receive tenders for lighting parts of the municipal buildings by means of the electric light, and has just issued an "Electric Lighting Specification," giving the following particulars of the installation, which consists of about 600 incandescent and four arc lamps. The specification includes: one best make locomotive tubular boiler, or other type, capable of supplying steam for 60 indicated horse-power; one high speed (vertical or horizontal) compound engine to develop 60 indicated horse-power, with broad fly-wheel to carry main belt to dynamo, and fitted with automatic expansion gear and sensitive governor, &c.; one dynamo (Edison-Hopkinson or Victoria preferred) capable of supplying current, if required, for 600 16-candle-power lamps, at a pressure not exceeding 120 volts—switch-board to be fixed on dynamo, arranged in order that the field circuits can be changed for charging accumulators or working direct; a battery of E.P.S. accumulators capable of running, say, 100 pilot lamps, required throughout the offices and corridor for a period of 10 hours; a main switch-board to be fitted in dynamo-room, with automatic cut-out to each circuit. Each department or room to be fitted with cut-out switch of approved pattern (Sir William Thomson's plug connectors preferred), placed in accessible positions near entrance door to each department or room. All wires to be of not less than 96 per cent. of the conductivity of pure copper. The dielectric to be of the best vulcanised India-rubber with a guaranteed insulation resistance equal to 100 megohms per 1,000 yards. The lamps to be of Swan, Edison, or Victoria best make, 16 C.P. each securely held in best socket holders or other approved pattern. Four arc lamps will be required in the quadrangle securely held in ornamental pillars. The lamps to be fitted with slightly obscure glass globes and weather protectors. The carbons to be 11 mm. and have a current of 10 ampères passing through them. A heat testing tube with ammeters and voltmeters will be required. The total number of incandescent lamps scheduled is 524, of which 231 will be constantly lighted and 293 occasionally lighted. The specification is prepared by Mr. Wm. A. Bryson, the engineer and electrician to the Corporation, also to the International Exhibition, Glasgow. There are sundry general conditions to which the contractors are bound; these relate to the time for completion and penalty for delay, test run of six consecutive hours, and the contractors have to guarantee the satisfactory working of the installation for 12 months. "For this purpose 20 per cent. of contract price will be withheld until this time expires, for the purpose of ensuring the making good any defects that may occur." The contractors have to supply all foundations and also brick-work and flues. The price of each article is required to be stated in full, and whilst the Corporation does not bind itself to accept the lowest or any tender, it shall be entitled to accept any item or items in any tender. Forms of specification may be obtained from Mr. J. D. Marwick, the Town Clerk of Glasgow, with whom the sealed tenders must be lodged on or before December 15th next.

NOTES.

The Legality of Improved Lighting.—At the last meeting of the Bournemouth Commissioners, attention was drawn to an item of £20 for the illumination of the pier by electricity on the occasion of the recent regatta. The Clerk stated, in reply to a question that he had a doubt as to the legality of the payment. The chairman observed that it would be bad form not to pay the account seeing that the electric lighting of the pier largely increased the sum taken in tolls. Mr. Fisher pointed out that when the Commissioners contributed £10 to the regatta fund some years ago, they were surcharged. Eventually the account was ordered to be paid.

Novel Use of the Electric Light.—Last week Sir G. W. Edwards laid the top stone of the tower of St. Agnes Church, Bristol, by the aid of the electric light.

Glasgow Lighting.—The Corporation of the city of Glasgow has issued a specification for the electric lighting of the Bazaar and City Hall, Glasgow by means of 30 arc lamps of 1000 candle-power each. The specification includes a boiler and engine of 50 indicated horse-power, suitable for electric lighting, two arc-light dynamos capable of supplying a minimun current of 10 ampères for 20 arc lamps on each, and provided with automatic current regulators. The lamps are to burn 12 to 16 hours without retrimming. The lamps in the City Hall are to be suspended by a concentric wire cable. A test run will be required of six consecutive hours under full load. "The contractor will have to guarantee the satisfactory working of the entire installation, so far as workmanship and materials are concerned for a term of one year from the date of its being taken over by the corporation. For this purpose 20 per cent of the contract price will be withheld until this time expires, for the purpose of securing the making good any defects that may occur." In addition to the points specified the contractors have to supply all foundations and boiler flues. It is required that the price of each article be stated in full, and although the "Corporation do not bind themselves to accept the lowest or any tender, they may accept any item or items in any tender." The consulting electrician is Mr. W. A. Bryson of the International Exhibition, Glasgow.

Electric Lighting in New York.—A contemporary states that in consequence of the competition between the seven large electric lighting companies of New York, the price of arc lighting in that city has been reduced from eightpence to sixpence, and in some cases to threepence, per lamp per hour.

Proposed Electric Lighting at Exeter.—An informal and private meeting, convened by circular, was held last week at Exeter to discuss the propriety of forming a company for the purpose of supplying the city with the electric light. The proceedings were held in the interest of the promotors of the Thomson-Houston system, and there was a fairly numerous attendance. No definite steps were taken, but several of those present offered to take shares should a company be formed. In the meantime Mr. Massingham proposes, with the consent of the authorities, to light experimentally a central area of Exeter, the Albert Museum, the Athenæum, and the establishments of several tradesmen. A second meeting to further consider the proposal of forming a company is to be held shortly. The Town Council has given its assent to the proposed experimental lighting.

Electric Lighting in Dublin.—The Corporation of Dublin will, on or before Friday, December the 9th, receive tenders for the lighting with electric light of streets in the City of Dublin, in length about 1,950 yards, for a period of seven years, from July 1st, 1888. The parties tendering will be bound to supply, erect, fix, and maintain all the necessary plant, machinery, engines, boilers, dynamos, conductors, pillars, &c., at their own expense. Water power is available on the property of the Corporation at Island Bridge, about two miles from the streets to be lighted. Specification, form of tender, and ground plan of Island Bridge and streets proposed to be lighted, can be had at the office of Mr. Spencer Harty, C.E., Borough Surveyor, City Hall, Dublin, on payment of one guinea, which will be returned to all persons sending in a *bona fide* tender. Tenders should be forwarded to Mr. John Beveridge, B.L., Town Clerk, City Hall, Dublin.

Lighting the Royal Yachts.—A proposal to supply the two principal Royal yachts with the electric light is said to have been submitted to Her Majesty, who has given her consent on condition that the new light is not introduced into the State apartments of the *Victoria and Albert*. There is no objection to all parts of the *Osborne* being electrically lighted. The estimate as to the cost is to be sent to the Admiralty, and it is understood that the work will be carried out while the usual winter repairs are in hand.

Electric Light Signalling at Sea.—An interesting experiment in long distance signalling has just been made by the officers of two ships of the Royal Navy on the East Indian station. The *Orion* was in port at Singapore, and the *Espoir* left for Hong Kong at a given speed of 10 knots per hour. When she had been gone long enough to have covered 60 knots the *Orion* flashed a message to her by means of the electric light directed against the clouds. It was not known at the time whether the message of four words was understood or not, but the *Espoir* has since reported that it was made out and replied to. It thus appears that the experiment was only partially satisfactory, but even this shows the possibility of signalling at hitherto undreamt of distances. The reading of the messages however will always depend upon the condition of the atmosphere, and no message could be read unless the clouds were well defined and low.

Electric Lighting in India.—Lord Dufferin's new Viceregal lodge at Simla is to be lighted throughout by electricity; nearly 1,000 glow lamps will be employed. The circumstance is noteworthy, inasmuch as this is the first Indian palace so lighted. The work is to be carried out by Mr. W. H. Massey, of Twyford, Berks, electrical engineer to Her Majesty.

The Watt Arc Lamp.—It is said that the Maxim-Weston Electric Company has already received a large number of orders for the new "Watt" arc lamp, and is in communication with the authorities of the City of London and other large centres with a view to street lighting by its means.

Electric Lighting in Factories.—In one large factory in the west-end of Dundee the electric light has been introduced and is giving satisfaction. In two other large works in the town the electric light is to be tried.

Electric Lighting on the Glasgow Underground Railway.—Several months ago a central rail was laid along both lines of the underground railway between College and Finnieston Stations to convey the current for lighting the carriages by means of electricity. Many of the carriages not being fitted with the incandescent lamps and the necessary connections, full advantage could not be taken of the electric light. At present, however, the trains running between Glasgow and Helensburgh, Balloch, and Milngavie are being provided with the requisite apparatus, so that they also may be expected to be soon illuminated by electricity. The trains running on the circular route by Maryhill, and also on the line between Airdrie and Hamilton and Hyndland, have been already supplied with the improved system of lighting. On an ordinary day no fewer than 250 carriages are in use on the underground railway, passing to and fro many times.

Canterbury and the Telephone.—Curious ideas prevail in Canterbury as to the utility of the telephone. At a recent meeting of the Town Council a proposal to give consideration to the question of establishing an exchange in Canterbury was ridiculed by several councillors, one saying that the telephone was a farce, and possessed no practical utility, and another that "they" (whether he meant the telephones or those who wished to use them was not clear) would no doubt set the Thames on fire. An amendment to let the matter rest was carried by 12 votes to 7, but the Mayor, Mr. Alderman Hart, Captain Lambert, Mr. Fielding, and others, having made a few sensible remarks pointing out the advantages of telephonic communication, a subsequent amendment to the effect that the Council should give an interview to Mr. Pidduck, the gentleman engaged in promoting the scheme, received an equal number of votes for and against, the Mayor thereupon giving a casting vote in favour of the interview.

Telephone Wires.—The United Telephone Company notifies its intention of applying to Parliament next session for an Act authorising it, or a company to be incorporated by the Act, to carry wires for telephonic communication over, along, or across any highways, streets, footpaths, or other public places, and any houses or lands within twelve miles of the General Post Office, and within other parts of the County of Middlesex; and to empower vestries and other public bodies and companies to enter into agreements for facilitating telephonic communication. Powers will be asked for to break up streets, erect posts on, and lay or carry wires for telephonic communication under or over any land, house, street, or other place within the limits mentioned, upon such terms, and subject to such conditions, restrictions, and regulations, as may from time to time be prescribed by the Board of Trade, the Metropolitan Board of Works, the City Commissioners of Sewers, or other public authority, "or otherwise as shall be provided by the intended Act." By other clauses, and for the purposes of the Act, authority will be sought for enabling the company or the new company "to acquire, sell, manufacture under, or otherwise use any patents and licences for the transmission of telephonic communication, and also to grant licenses to manufacture under or use any such patents, either within or without the limits aforesaid."

The Telephone in Fife.—Long wooden poles have been laid along the Dundee and Edinburgh road in Fife, passing the Old Jail at Cupar, for the fitting up of wires for the National Telephone Company. Cupar will thus be placed in telephonic communication with towns both north and south.

The Telephone in Ayrshire.—The National Telephone Company is about to extend its system to Dalry, Ayrshire, and open an exchange for the district.

Telegraph Map.—The Bureau International of Berne has lately published a new map of the telegraph communications of the world. A single copy costs, post paid within the limits of the Postal Union, 40 centimes.

Western Union Telegraph Company. — With the absorption of the Baltimore and Ohio Telegraph Company, and upon the completion of certain lines now under construction, the Western Union will own about 156,000 miles of line, representing not much less than 600,000 miles of conductors.

The Telegraph in Tonquin.—In Tonquin and Annam there are about 2,500 kilometres of telegraph lines in operation, while about 1,000 kilometres are in course of construction or determined on. Among the latter are lines which will connect with the Chinese telegraph system.

An American Government Telegraph System Proposed.—Senator Edmunds announces that he will reintroduce and press his bill for the establishment of a Government telegraph. The bill does not provide for the purchase or leasing of any existing lines. It contemplates the construction of an independent line between the larger cities, and the extension of the system gradually over the country.

The Telegraph between Burmah and China.—The London correspondent of the *Manchester Guardian* hears that Sir John Walsham, British Minister at Pekin, is negotiating with the Chinese Government for the addition of an article of great importance to the lately ratified convention about Burmah. This clause has relation to the telegraphic systems of Burmah and China, and provides for their connection at the frontier. As yet no telegraph crosses the frontier of China at any point. The Burmah lines have long been completed to Bhamo, and the telegraph has reached Yunnan long since. If the two systems were connected and a new route between China and Europe thus secured, merchants having business with the Far East would find the benefit immediately. The present rates are maintained by an agreement between the British Cable Company and the Danish Siberian Company.

The Telegraph in Central Asia.—A telegram from Calcutta announces that the telegraph up the Khyber has been completed to Lund-i-Kotal, Cabul being thus brought within 140 miles of the wire.

Italian Cables.—The contract entered into on April 15th, 1886, between the Italian Government and the firm of Pirelli and Co. entails upon the latter the construction, laying, and maintenance of 13 cables, comprising about 712 kilometres of cable. Nearly all these cables are of short length, and will lie in shallow water, connecting with the mainland the following islands: Ustica, Pantelleria, Stromboli, Ponza, Ventotene, Gorgona, Capraia, Pianosa, Giglio, Tremiti and Vulcano. The most important line is that between Naples and Palermo, touching at the island of Ustica. We understand that a portion of this section will pass through a depth of 1,600 fathoms at least.

People's Lectures.—These lectures, to which we alluded in our last issue, are carried out under the auspices of the London Society for the Extension of University Teaching and of the Gilchrist Trustees. There will this winter be 10 courses delivered by various men. On the 28th the second lecture, by Mr. W. Lant Carpenter, on "Electricity in the Service of Man," was given in the Shoreditch Town Hall, the room being filled to overflowing; the subjects were, "Electrolysis," "Electric Lighting," and "Electrical Transmission and Distribution of Power."

Gas Lighting by Electricity.—The Woodhouse and Rawson Electric Supply Company of Great Britain, acting as agents to the Electric Gas Lighting Company, has received the highest award, namely a diploma of honour, for its exhibition of electric gas lighting appliances, burglar alarms, &c., at the American Exhibition recently closed.

Did We Say So?—We notice in the last issue of *La Lumière Electrique* the following paragraph:—"Our contemporary, the ELECTRICAL REVIEW, of London, ascribes to the French Government the intention of laying a cable across the Channel with the view of establishing direct telephonic communication between Paris and London??" Our esteemed fellow labourer in the cause of science does well to mark this information with notes of interrogation. Doubtlessly it is implied that were the French Government inclined towards such a step, there would still remain certain formalities to be conducted on the English side of the Channel; and, in view of the present hitch with regard to the Submarine Company's monopoly, the moment is scarcely opportune for any such scheme.

Removal of Messrs. Laing, Wharton and Down.—Holborn Viaduct, which at one time bid fair to become the centre of electric enlightenment and the favoured locality of electric lighting companies, has gradually been deserted, voluntarily and otherwise, by the firms who formerly had there their local habitations and their names. The tendency amongst those whose removal has been a matter of choice, has been to get westward, and in that part of the Metropolis also is now to be found the locality best off in the matter of electric lighting, namely, the neighbourhood of the Grosvenor Gallery. Messrs. Laing, Wharton and Down announce that on and after to-morrow (December 3rd) their address will be 82, New Bond Street, where they will be better situated for carrying on their increasing business and also have finer showrooms for their specialities, including the art metal fittings to which they have devoted so much attention. With reference to the Thomson-Houston system they are anticipating a development in this country proportional to its remarkable success in America.

Prospectus Misrepresentations.—A valuable and important decision was recently given by Mr. Justice Kay in an action to enforce "specific performance" of a contract for the purchase of letters patent. The defence to the action was that the plaintiffs, the vendors of the patent, had misrepresented essential facts; and the learned judge held that any material misrepresentation, even if made "innocently and in the absence of anything like fraud," was a sufficient answer to an action for specific performance. This should be good news to those who have been victimised by the false representations of vendors, for it is clear that the sums paid to the latter are recoverable in such circumstances.

A New Journal.—We welcome the appearance of a paper which has for its object the lessening of fire risks. *Fire* is a monthly "insurance" journal, and is published at the rather high price of 1s. Its first number discusses with much ability the subjects of fire inquests, electric lighting, fireproof construction, &c.; contains scientific and practical notes; notices of inventions and improvements; and a startling fire-roll for the month.

Copper Wire.—There has been a remarkable rise in the price of copper within the last week or so, and copper wire has also gone up in sympathy. There seems to have been a considerable restriction in the supply of copper latterly, and at the same time a tendency on the part of the demand to increase. We are informed by Messrs. Frederick Smith & Co. that their present basis price for all kinds of copper wire, high conductivity, hard drawn, plain or tinned, 0 to 20, is 10d. per lb.

Royal Society.—Prof. G. G. Stokes in the anniversary address of the Royal Society on Wednesday, made reference to the jubilee of the electric telegraph, and said the name of their former Fellow, Wheatstone, would go down to posterity as having occupied a foremost place in this great practical application of Œrsted's fertile discovery. At a later stage, dealing with the question, "What is electricity?" he said that so closely was electricity allied to chemical action that could we only clearly apprehend the nature of electricity it seemed not unlikely that an unexpected flood of light might be shed upon chemical combination.

Worthy of Consideration.—The letter of Mr. A. R. Bennett will be perused with interest, as it opens up a new field for the consideration of the Society of Telegraph Engineers and Electricians. Some of the suggestions are well set forth, but Mr. Bennett must surely be in error if he thinks that the proceedings of the society are not known almost immediately after each meeting. The REVIEW and other technical journals endeavour to give full particulars of all which transpires at these gatherings, and in some instances the papers and discussions thereon are given *verbatim*.

Provisional Order.—Amongst the plans deposited for private bills intended to be proceeded with next session, the only electrical one is an application for a provisional order by the South Metropolitan Electric Supply Company.

The Society of Telegraph Engineers and Electricians.—The annual general meeting will be held at 25, Great George Street, S.W., on Thursday, December 8th, for the reception of the annual report and the election of council and officers for the year 1888. The following paper will be read, "On Safety Fuses for Electric Light Circuits and on the fusing points of various metals usually employed in their construction," by Arthur C. Cockburn, F.C.S., Associate.

Personal.—Mr. Rashleigh Phipps desires us to state that he has taken into partnership Mr. A. R. Dawson, late of the United Telephone Company and Messrs. Judson's Electrical Works, Southwark, and that the style of the firm will now be Messrs. Rashleigh Phipps and Dawson, carrying on business at the same address as heretofore, as electric light engineers and contractors.

Mr. A. J. Stubbs has been appointed to the position of second class technical officer in the Engineer-in-Chief's office, General Post Office.

More Journals.—After less than a year's existence as a monthly, *Scientific News*, the motto of which is "Light, more Light!" is to be published weekly from the first week in January, 1888.

Munificent Dividend.—A first dividend of 4d. in the £ has been declared on the estate of Baron Albert Grant. *Money* asks, "Will the recipients of the 4d. know what to do with the money?"

Dutch Telegraphs.—Some interesting statistics of the telegraphs in Holland for 1886 are published in the last issue of the *Journal Télégraphique*. The classes of telegrams are divided into:—

Government messages	0·16 per cent.
Stock exchange	7·28 ,,
Business transactions and shipping news ...	50·18 ,,
Press messages	3·08 ,,
Private affairs	39·30 ,,

The facilities offered for transmitting the same telegram to various addresses have been taken advantage of in the following proportion:—Two addresses, 899 telegrams; three, 169; four, 63; five, 36; six, 33; seven, 13; eight, 3; nine, 4; eleven, 1; twelve addresses, 1 telegram. The excess of expenditure over receipts shows a very considerable diminution as compared with former years:—1884, 585,161 florins; 1885, 573,487 florins; 1886, 422,865 florins.

NEW COMPANIES REGISTERED.

South Metropolitan Electric Supply Company, Limited.—Capital: £250,000 in £10 shares. Objects: To produce electric, magnetic, or other force, and to supply the same for light and heat. Signatories (with one share each): J. C. Parkinson, J.P., 91, Victoria Street, S.W.; E. R. Creed, 1, Baldry Gardens, Streatham; W. Stopford Smythe, C.E., Newport, Mon.; T. L. Eastlake, Fairlawn, Balham; J. P. Linton, 15, Melrose Terrace, West Kensington; J. Beavan, 9, Blucher Road, Camberwell; S. Bircham, 46, Parliament Street. Registered 26th ult., without articles of association, by Bircham & Co., 50, Old Broad Street.

Medico-Electric Belt, Truss, and Battery Company, Limited.—Capital: £20,000 in £5 shares. Objects: To take over the business of the Medical-Electric Belt, Truss, and Health Appliance Company, Limited, (in liquidation.) Signatories (with one share each): *J. V. Barber, 7, Elworthy Terrace, Primrose Hill; *L. Levy, 72, Avenue Road, N.W.; *M. Phillips, Constitutional Club; Eliza Wood, 58, New Bond Street; F. Wood, 58, New Bond Street: *W. J. Johnson (electrician), 64, Cambridge Terrace, Hyde Park; H. R. Bate, 19, Pembury Grove, Hackney Downs. The signatories denoted by an asterisk are the first directors. Registered 28th ult. by Snell, Son and Greenip, 1 and 2, George Street, Mansion House. Registered office, 58, New Bond Street.

Railway, Tramway, and General Appliances Company, Limited.—Capital: £100,000 in £5 shares. Objects: To construct, improve, equip, manage, and control railways, tramways, and other works of public utility, and to carry on the business of mechanical and electrical engineers. Signatories (with one share each): J. Alexander, Danby Street, Peckham; F. T. Marney, 10, Bradle Road, Wood Green; E. T. Botwright, 23, Sutton Place, Hackney; E. S. Harper, Goodrich Road, Forest Hill; J. H. Chapman, 64, Wellington Street, Woolwich; S. J. Prosser, 84, Loampit Vale, Lewisham; W. C. Horton, 7, Moncrieff Street, Peckham. The signatories are to nominate the first directors. Qualification: £100 in shares. The shareholders in general meeting will appoint the remuneration of the board. Registered 29th ult. by A. M. Bell, 40, Tredegar Square, E.

Orient Electric Light Company, Limited.—Capital: £5,000 in £250 shares. Objects: To carry on in all branches the business of an electric light and power, telegraph, and telephone company in the United Kingdom, India, Burmah, Ceylon, or elsewhere. Signatories (with one share each): W. Martineau, C.E., 6, Great Winchester Street; K. Hedges, C.E., 25, Queen Anne's Gate, S.W.; W. J. Andrewes, Palace Chambers, Westminster; G. W. P. Woodroffe, East India Avenue; S. Hedges, 83, Lombard Street; H. Tate, 21, Mincing Lane; F. J. P. Birch, 8½, Angel Court, E.C. Registered 29th ult. by Wilson, Bristows, and Carpmael, 1, Copthall Buildings, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Electrified Rooms Company, Limited.—The statutory return of this company made up to August 23rd was filed on August 27th. The nominal capital is £25,000 in £1 shares. The number of shares taken up is 5,385. Upon 5,360 shares the full amount has been called, and upon 25 shares a call of 2s. 6d. per share has been made. 4,950 shares are considered as fully paid, and the sum of £703 2s. 6d. has been received in respect of calls. Registered office, 24, Landport Terrace, Southsea.

Armstrong's Electric Light and Power Company, Limited.—An agreement of the 1st ult. provides for the purchase by the company of the trade marks and patent rights of Mr. J. Tarbotton Armstrong, 145 and 147, Bermondsey Street, for £500 cash and 9,500 fully paid shares of £1 each. The trade marks relate to Armstrong's Master Battery, Class 8, 54,645,

"Electronite," and Device, Class 1, 60,433, "Electronite," 60,434, Class 8, copyright of work called Catalogue of "Armstrong's Patent Master Batteries," entered at Stationers' Hall. The patents relate chiefly to electrical batteries and are as follows:—No. 6,878, June 5th, 1885; 2,165, February 17th, 1885; 14,383, November 24th, 1885; 398, June 9th, 1886; 8,573, June 30th, 1886; 10,824, August 24th, 1886; also provisional specification, April 4th and 29th, 1887, and patents for France, Belgium, Germany, and the United States. Registered office, Palace Chambers, 9, Bridge Street, Westminster.

Woodhouse and Rawson, Limited.—The statutory return of this company made up to the 16th ult. was filed on the 22nd ult. The nominal capital is £200,000 divided into 39,980 shares of £5 each and 100 founders' shares of £1 each. 14,100 shares have been taken up, and £1 15s. per share has been called upon each £5 share. The calls paid amount to £22,150 5s., leaving £2,524 15s. unpaid.

Medical Electric Belt, Truss and Health Appliance Company, Limited.—An extraordinary general meeting of this company was held at 58, New Bond Street, on the 5th ult., when it was resolved that the company be wound up voluntarily with a view to reconstruction, and that Mr. Walter Biggs be appointed liquidator. The resolutions were confirmed on the 24th and duly registered on the 28th ult.

International News Association, Limited (For supplying telegraphic and other news).—The statutory return of this company made to June 17th was filed on the 23rd of that month. The nominal capital is £30,000 in £1 shares. 25,007 shares have been allotted, and of these 25,000 are considered as fully paid, and no call has been made upon the remaining seven shares.

Marine Life Saving Appliances Company, Limited.—The registered office of this company is at 377, Strand.

CITY NOTES, REPORTS, MEETINGS, &c.

German Union Telegraph and Trust Company, Limited.

AN extraordinary general meeting of this company was held, under the presidency of Sir James Anderson, on Monday, at Winchester House, Old Broad Street, for the consideration of proposals received from the German Government for the acquisition of the cables and property of the German Union Telegraph Company of Berlin.

Mr. William Payton, the Secretary, having read the notice convening the meeting,

The Chairman said he proposed to give the shareholders as clear a statement as he could of the circumstances that were leading to the sudden termination of the existence of the company—a company which until very recent days he regarded as likely to retain the position of doing all the submarine cable work which Germany might desire. A few weeks ago two of the leading officials of the German Postal and Telegraphic Department were in London, and he believed that it was then decided that Germany and the English Post Office should either acquire the existing cables or lay their own cables, and that the two Government telegraph administrations should work the traffic at a reduced tariff. The German Government could not, of course, cancel this company's concession, which had still 11 years to run, but this concession was not exclusive. It was worked in concert with the German Telegraph Administration. They had also agreements with the Submarine Telegraph Company, whose concession ended next year, and with the Anglo-American Telegraph Company. This latter agreement would be taken over and carried out by the German Telegraph Administration. In the latter days of October the Berlin Board of the German Union Company were called upon to negotiate for the sale of the company's cables or submit to the opposition of Government rival cables, at a tariff which, even with a very large amount of traffic, would yield a very small revenue. Those negotiations were carried out by Dr. Lasard (the managing director in Berlin), and he must say very ably carried out, and practically the result was that they were offered the first cost of the cables—one of which was 17 years old—and they were allowed to retain their reserves. They were called upon to reply promptly. It must, he said, be admitted that the sum of money offered by the German Government for their property, viz., £315,000—which together with their reserves and the interest for 1888 would yield if invested in German Rentes 4 per cent. interest in perpetuity on the original share capital—could not be called inequitable but the shareholders would naturally say that was all very well for the original shareholders in the German Union Company, but what about the German Union Trust, of which they were shareholders, and who did not get par for their shares? Well, he had to tell them that the German Government never recognised this Trust Company, and did not now recognise its existence, although they had always acted as the London agents for the Berlin company. The original shares were £15 per share, and when the Trust Company was formed the nominal value of the shares was made £20, in two £10 shares. The amount of money now offered to them was sufficient, with the reserves and interest and dividend of 1888, to give them about £19 on the original shares of £15 and £9 10s., or a little more, upon the existing shares. Of course, as the money would not be paid until January, 1889, and there might be repairs or accidents in the interval, the exact amount could not be estimated accurately, but £9 10s. to £9 15s. was the present estimate, allowing for the usual expenses, and it must be understood that these sums were made up by including next year's revenue, and, as he had already said, reserves and interest, and, in fact, all their resources, and therefore after the dividends which it was intended to pay in January and March next there would not be any more interest, but simply a return of capital in January, 1889. He might remind them that all the trust shareholders had an opportunity of subscribing for preference capital, so that the majority of the shareholders who did so would have a fair average return on their investment. He must say that their first impression of the amount approved was disappointing, as it did not give them par for their Trust Company's shares, nor were they afforded sufficient time to consider the proposition. He (the chairman), accompanied by Count Reichenbach and Mr. Payton (the secretary), went to Berlin to see if anything could be urged to improve the position, but the Director-General of Posts and Telegraphs, who was *ex officio* a member of the council of supervision which controlled the German Board of Direction, very definitely said, "There is the proposition, and I am instructed to urge its prompt acceptance, or we will lay our own cables." They had, therefore, returned with the conviction that it was to the shareholders' interest to give the power to accept the offer of the German Government. He might say that the Globe Company, which held half the capital, had already agreed to accept. The power of attorney must leave for Berlin that night to be in time for the general meeting in Berlin for December 1st, and the reason for this urgency, he understood to be the necessity of including the amount he had named in the budget to be presented next month in the Reichstag or alternatively some other sum for new cables, if they declined. He moved in conclusion, "that the board of directors be, and they are hereby authorised, to agree on behalf of this company to the terms proposed by the Imperial German Government for the purchase of the cables and property of the German Union Telegraph Company, of Berlin, and to take all such steps as they may deem necessary or expedient to have such purchase completed."

Count Reichenbach seconded the motion.

The Chairman, in replying to a shareholder, said that the German Government made no distinction between preference and ordinary shares, and both would receive alike under the proposed arrangement.

Mr. W. Griffith thought their "very good friends, the Germans," offered scarcely a good enough price for what they evidently regarded as a valuable property. The reports for the last five or six years showed that the average return on the investments in the company had been about £5 18s. per cent.; last year the dividend was £6 per cent. Their shares stood in the Stock Exchange list at 10½ to 11.

A Shareholder: Yesterday the price was 9½.

Mr. Griffith, continuing, said that showed how this proposal had affected the price of the shares. When they considered that this was a good sound 6 per cent. investment, he did not think they would consider 10 or 11 an outside price. In these days it was difficult to get a good 5 per cent. investment; but here was a much better return, and they were asked to give up the investment for a sum below par. His shares cost him, when stamp, commission, and other items were reckoned, nearly £11 each, and when they came to re-invest their money, after the cost of the stamp to the Government, commission to the broker, and a certain fee to the new company had been paid, it would be found that the £9 15s. they were promised per share would be diminished by about 10s. Their property was good and likely to improve.

The Chairman expressed dissent.

Mr. Griffith said the directors told them that next year they expected to be in a position to pay, not 6 per cent. as last year, but 7½ per cent., which showed that the investment was improving. The large development of business between England and America was likely to continue as long as the present low rates prevailed, and upon these grounds he could not consider that they would be acting wisely in at once accepting the proposal. The very urgency which was used was a proof that the German Government thought it had a good bargain. The Germans were good men of business, and he did not think they would divide the profits by laying new cables; if they did so, they would injure themselves more than this company, which possessed agreements with the Submarine and other companies which they did not, and a new cable could only control the traffic from Germany to England, and not from England to the United States. He thought the German Union shareholders had better keep what was really a good and safe investment than take cash and invest it in something else which might be of a more speculative character.

Mr. A. Lowenthal, who said he had written to the secretary, urging precisely the objections which Mr. Griffiths had stated to the proposal, asked what was the cause of the shares falling within two or three days from 10¾ to 11 to 9¼. Had any of the directors sold shares after learning what was about to take place?

The Chairman: Certainly not.

Mr. Lowenthal said they ought not to allow themselves to be browbeaten. He should have thought that the English Government would protect them in this matter, and if the directors could not effect a bargain with the German Government, he thought they should at all events go to the English Government and state their case. If the directors knew this matter was coming on they ought to have communicated with the shareholders, so as to prevent them from doing as he had done; believing that the investment was a safe one he a fortnight ago added 75 shares to the 175 he had held from the inception of the company. Upon these 75 shares he would lose about £70 or £80.

The Chairman said the board knew no more than the shareholders until three weeks ago. The German Government had for some time been in communication with the English Post Office and with all the other Continental Governments, and they had jointly determined to acquire their own cables, retain submarine concessions as soon as they lapsed, and reduce the tariffs. The tariff which would remain to them if they chose to continue working their cables was ½d. a word, which, supposing the cables were full, would not much more than pay the working expenses. They would have as rivals the English and German Governments. They could not expect them (the directors), therefore, to go to the English Government and ask it to make the Germans give them more money. They did and said all that was possible when they went to Berlin, but it was of no use. They did not lose a moment after hearing of this in going to Berlin and summoning that meeting. Power of attorney must go to Berlin that night or their property was not worth a farthing. That was the position which he, as chairman, put before them, and he could not suppose that they would be so stubborn as to refuse the offer.

The motion was then put to the vote and carried, with but one dissentient.

Mr. Griffith said they ought to support their directors as men of integrity, and be thankful for what they had done: but they would merely express a hope that they would yet be able to do something better for them.

The meeting was then brought to a close with the usual votes of thanks.

South of England Telephone Company, Limited.

As announced in our last issue, the half-yearly general meeting of this company was held on Thursday, the 24th ultimo, at Winchester House, Old Broad Street, Mr. D. O. Bateson, the Chairman, presiding.

Mr. F. L. Robinson, the Secretary, read the notice convening the meeting, after which

The Chairman said: In compliance with the resolution passed at our general meeting in June last we have called you together to-day. I think, however, that we could have told you everything relative to the company's progress by circular instead of giving you the trouble to attend personally; but, as far as your directors are concerned, they have not the slightest objection to the meeting, and it affords them the opportunity of rendering an account of their stewardship during the past half-year, and of answering any questions upon which the shareholders desire information. The time under review has been extremely uneventful; indeed, I may say we are in the happy condition of that country that has no history. We have met with no disaster of any kind, as far as I am aware, and our progress in new work has been to a satisfactory extent. Our system has withstood the gales of the autumn, proving that the lesson taught by the collapse last winter has been well learnt. The number of our exchange lines has increased by 186, and private lines by 25, and our gross rentals show £1,500 increase for the half year. We have laid trunk lines between the towns of Brighton and Lewes, Brighton and Shoreham, and between Margate, *vid* Broadstairs, and Ramsgate. This latter line is intended to be connected with Westgate as soon as we can get wayleaves through. The Brighton and Lewes line is an instalment towards Eastbourne. At the moment the latter route is suspended—temporarily, we hope—consequent on wayleave difficulties, which, we trust, may be got over ere long. The Margate and Ramsgate exchanges are in process of development, and we think they give good prospect of success eventually, though this year we have great complaints of the unprofitableness of the last season in both places. Our centres north and west of London are doing a good steady business. Reading makes satisfactory progress, and Cambridge is doing very well. I am sorry to say that Oxford lags sadly behind the sister University, and we find much difficulty in getting along there. Northampton, Norwich and Ipswich are doing pretty fairly, though perhaps hardly as well as we could wish. We have great complaints of the badness of trade in these districts. Our other stations are well seen to, and whenever we see a prospect of doing any paying work our energies are devoted to looking after it. I am glad to say that as a rule the public bodies in the various towns we are in welcome us in the light of public benefactors and give us valuable assistance. Here and there, however, individuals give us some trouble and impede our progress; but, upon the whole, we have really little to complain of on this score. Our relations with the Post Office are of the most amicable kind. We never have any controversy with this branch of the public service. I must also bear my testimony to the kindness and consideration of the various railway companies in our district, both in granting us wayleaves, &c., and in renting lines from us where they can be made useful. We always endeavour to put them on the most favourable terms possible as regards cost. I regret to say we have come no nearer to a junction of our system with that of the United Company in order to enable our subscribers to converse with London and *vice versa*. We have loud and continuous complaints that we are unable to effect this most desirable end, and have made representations to the parent company about it. As you are aware, we do not produce any financial statement at this period of the year. I may, however, state that your directors are satisfied with the progress of the business, and they have every expectation that at the annual meeting in the spring of next year they will be able to give a good account of themselves. I have no resolution to propose on this occasion.

Mr. Roe, of Ipswich, said that at the last meeting he was opposed to some of the views of the board, but he was not in that position upon this occasion. He had been endeavouring to get a trunk line established from Ipswich to Stowmarket, because he had reasons for believing that such a line would be a success; and after that he thought a trunk line might also be run between Ipswich and Felixstowe. He had found a difficulty, however, in the fact that it was necessary for a sub criber to the trunk line to be a subscriber also to the exchange, and several influential people who would like to be able to use the trunk line thought they did not need the facilities given by the exchange, and they did not care to pay £10, the exchange subscription, in addition to the £6, which would be about the sum for the trunk line subscription. He wished now to ask the directors if they could not consider the matter with a view to an arrangement upon this point.

The Chairman said he would be glad to talk the matter over with Mr. Roe after the meeting. The directors had been trying to run that line for the past two years, and they were most anxious to run it as soon as they could see the prospect of a paying price.

Dr. Ellis, of Eastbourne, said if the present rate of progress continued, the success of the company as a dividend-paying concern was assured. He suggested that efforts should be made to procure connection with the post offices throughout the district, so that telegrams might be sent direct from the houses of the subscribers. This would be a great boon in cases where houses were at some distance from a telegraph office. He further suggested that a call office should be established at all leading railway stations. Dr. Ellis then referred to difficulties which had been encountered at Hastings, and advised the directors not to submit to the attempts which were made to levy blackmail upon them, and also to spread information about the telephone amongst the populace.

The Chairman said the Post Office objected to the establishment of telephones at railway stations. They had tried very hard to get one at the station at Brighton, but without avail. They endeavoured, however, to get call offices as near the stations as possible. The authorities at Hastings had certainly thrown a certain amount of difficulty in their way with regard to the running of overhead wires, and some of their strongest opponents were persons who had perfect information of the difficulty and the expense of going underground. They had been threatened that their lines would be cut, but he did not agree with Dr. Ellis that it would be wise to allow the people to cut the wires if it was to be avoided. All their revenue went as soon as the wires were cut, for the subscribers considered that their rental ceased as soon as they ceased to enjoy the privileges of connection.

Dr. Ellis said he thought the chairman misunderstood him. He would rather allow a man to cut the line crossing his property than give way to him and allow him to have a wire free. There would be absolutely no end to that kind of thing if it were once permitted.

The Chairman fancied they would have to leave that matter very much to the discretion of the directors. They did the best they could in each instance. Sometimes it was absolutely necessary that a line should run in a certain direction: they could not go on without it. At Hastings they had at that moment the greatest difficulty to get over Warrior Square. Whether or not they would be obliged to go underground there he did not yet know. They had 16 or 17 wires going over Warrior Square, and they had received notice to take them down.

Mr. Roe said they must live that kind of opposition down.

Some further conversation took place with regard to the advisability of establishing call offices in suburban districts, so that residents there might be enabled to communicate with the tradesmen in the towns, the Chairman remarking that that was a branch of their business which they were assiduously cultivating, and the meeting thereafter terminated with the usual vote of thanks to the chairman and directors.

The Blackpool Electric Tramway Company, Limited.

THE annual meeting of the shareholders of this company was held on Saturday, under the presidency of Mr. R. Horsfall, Mayor of Halifax.

The Chairman pointed out that the company had suffered an unfortunate mishap during the year in the failure of the insulation of the line. This had put them to considerable expense in horse hire and in repairs, and then, again, they had had to contend

against great competition from the omnibus proprietors. He complained that they were most unfairly dealt with by the Corporation of Blackpool, who allowed the omnibuses to run on Sundays, but prevented the tramcars from carrying passengers on that day. The old insulators were being replaced by new and more effective appliances, and after their experiences of the past year he had increased confidence in the concern, and he anticipated that at their next meeting he would have a much more favourable report to put before them.

No dividend was declared; a sum of £471 being carried forward to the reserve fund; and Messrs. Kingsbury, Ormerod, Shaw, and Smith were re-elected directors.

Spanish National Submarine Telegraph Company, Limited.—It is notified that 66 debentures of £100 each of this company's six per cent. mortgage debentures have been drawn, and will be paid off at par on and after December 31st next.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending November 25th were £3,563, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ended November 25th amounted to £4,491.

CORRESPONDENCE.

Primary v. Secondary Batteries.

Sir William Thomson does not need an apologist for his statements, nor do I place myself in that capacity. If I understand properly, his allusion to the time occupied in re-charging secondary batteries as an increase of expense is, that in order to keep three shifts of men at work in a coal mine day and night, three sets of miners' lamps have to be provided for each man employed; whereas with a primary battery lamp like mine, which can be charged in less than a minute by the man himself, *two* only for each man would have to be provided. Now, taking into consideration that the first cost of a secondary battery is higher than that of a primary battery lamp, and that a small mine with 500 men to be provided with lamps, by using the secondary battery 1,500 lamps are required, as against 1,000 primary batteries, and counting that the outlay for first cost will be very large, and that the interest on this capital must be considered as a loss, I think that if looked on from this point of view the opinion of Sir William Thomson will be acknowledged to be correct. Apologising for taking up so much space,

A. Schanschieff.

London, *November 30th*, 1887.

[If Mr. Schanschieff choses to look upon Sir William Thomson's report in another light than that in which we view it we cannot help it. That eminent electrician says of the Schanschieff battery:—"After being run down it can be charged again in half-a-minue or a minute, unlike a secondary battery, *which requires many hours to charge*, and a dynamo to effect the charge." On the face of this we see no reason to take back anything we have said.—EDS. ELEC. REV].

Primary Batteries.

I notice in your issue of November 18th, a letter from Mr. A. R. Bennett in which he makes certain comparisons between his oxide of iron cell and the Lalande oxide of copper cell. In his letter he states that the Lalande battery is really only a modification of the one bearing his name, the difference being in the use of oxide of copper in the iron cells, instead of iron or steel borings, and the result of the difference being that the Lalande battery has an increase of quantity and constancy, and a decrease of electromotive force. Mr. Bennett's statement here is perfectly true as regards the latter part of the sentence, and if he likes to look upon the Lalande battery as only a modification of his, well and good; but most people would consider that there is a considerable difference in the use of copper, and in the use of iron, still more so in the use of *oxide* of copper as against the use of *oxide* of iron when used as depolarisers. As a matter of fact, the difference, as he states, does give the Lalande battery increased constancy and increase of quantity, and another more remarkable property into the bargain, namely, a remarkably low resistance. This is the whole point, and for that reason many well-known scientists (whose reports on the battery are now published) consider that the Lalande battery is a remarkably good one.

You were kind enough to give to your readers last year a complete description of the Lalande battery as used in conjunction with accumulators, and it is needless for me to go over the various advantages that it has (for it was thoroughly demonstrated then), but the principal one is that it is not necessary to employ more than six cells in series, to give us the requisite E.M.F. to overcome the resistance of the accumulators when charged in quantity.

Mr. Bennett's statement as regards the date of the patents is all correct, but I have to draw his attention to the fact that the proprietors do not claim the recovery of zinc oxide, but *oxy-sulphide* of zinc which is a very different thing to an oxide of zinc. There was every reason to suppose when the process was elaborated for obtaining a good pigment in the form of sulphide of zinc, that there was a large market for it. But subsequent experience has not borne this supposition out, although there is no doubt that were the sale of this commodity well pushed there would be a considerable demand.

The proprietors of the Lalande battery were informed some time ago that Mr. Bennett intended taking legal steps to prove that Monsieur de Lalande's battery was an infringement of his form of cell; but Mr. Bennett did not go on with it, and I, as being interested in the Lalande battery, would be very glad if he would do so, with a view of settling the matter once and for all, if he considered that M. de Lalande infringed his patents. The proprietors of the battery do not *now* look upon the residual product in the form of oxide, sulphide, sulphate or chloride of zinc (all of which are obtainable from the spent liquor of the battery) as the most valuable branch of their process, although they are of great value, because they are now enabled by another and a new process to obtain a very much more valuable product, which has an absolute and certain market price, and is in great demand. In the course of a few weeks, I well send you fuller details and actual experiments, and practical and profitable results therefrom, which may be interesting to your readers.

I write this with all courtesy to Mr. Bennett, whose invention I believe to be of considerable value for the purposes to which he applies it.

Hugh A. Fergusson.

November 23rd, 1887.

The Proposed Association.

Week after week do I take up your review, longing for some few remarks bearing on the proposed electric association but which shall be *unbiased* in views. Not one has yet appeared. But why? Because those who have of late written to your columns are "heads of firms." Now if this is to continue, no possible result can be obtained except it be to drop the subject in disgust. It seems to me that electricians feel the want of something, but what that something is, I do not think they are quite clear upon. They imagine what they want to be a sort of "guilds," such as the "Ironmongers'," "Drapers'," &c. Is what we want to be a sort of trade union? I hardly think so. What we require is an association for the free consideration—on a larger scale than carried out by the British Association—of *all* things electrical. I underline "all," for all who have written to your columns have as yet misused the term, confining themselves almost exclusively to matters which shall advance the profession as far as

the pocket is concerned, but they entirely ignore the science and theory of electricity, leaving that for others. We require an association which shall debate on all that shall *advance* the profession, and, to my mind, the profession will never improve as a trade so long as it is at a standstill in theory. All points should be taken in hand.

To form such an association is not feasible so long as our ideas are debated on paper, for the simple reason that we have but few who do write in comparison with those who do not, and the few who do, do not take the trouble to tell us everything they think; besides, many would change their ideas if they heard the views of another. We should all agree to form a sort of congress in which all friends of our profession should take a part and amicably talk over what steps we think should be taken in the matter and how they can best be carried out.

Charles Latimer.

Balancing Friction by Magnetism.

The letter of Mr. Gerald Percival, contained in your issue of November 4th, and headed "Electric Street Cars," opens a discussion upon a subject which has occupied my attention for some time, but in a direction somewhat different from that indicated by your correspondent.

Mr. Percival suggests that the thrust of a worm may be eliminated "by shifting the position of the armature of a motor longitudinally on its shaft, so that it stands to one side of the usual central position between the pole-pieces, it being shifted in the same direction in which it would be by the end thrust of the worm if no collars or equivalent devices were provided on the axle to prevent longitudinal motion."

At first sight this seems a simple expedient. No doubt it answered fairly well when applied to a small model; in practice, however, when transmitting energy of several horse-power certain difficulties will become apparent. With rationally-constructed electro-motors the magnetic attraction or repulsion in the direction parallel to the shaft is comparatively small.

It must be remembered that in the case of tramcars the tractive force, when the vehicle is not descending an incline, seldom amounts to less than 200 lbs. This force would involve a very great displacement of the armature relatively to its field-magnets, and thereby distort the magnetic lines of force to an extent which would reduce the efficiency of the machine very considerably. The waste of electrical energy, I fear, would be greater than the loss through mechanical friction in the unbalanced thrust bearing.

A more economical plan is to convert the motor shaft into an electro-magnet, and to let its end work against a cast iron thrust bearing which is in a similar magnetic condition, so that the two repel each other. This is the direction in which I have been working, and I intend to continue my experiments in order to arrive at definite data for purposes of comparison. I should like to ask Mr. Percival whether he tested the efficiency of his small motor at the same time when he measured the longitudinal thrust; exact figures relating to his experiments in this direction would prove interesting.

A. Reckenzaun.

Philadelphia, Pa., U.S.A.,
November 17*th*, 1887.

The Lever Dynamo.

I should not have troubled you again on this subject, had it not been that Mr. Esson, on behalf of Messrs. Paterson and Cooper, stated in your last issue that the output of a particular "Phœnix" dynamo, which I gave as 2,400 watts at 1,600 revs., is "quite erroneous." As a matter of fact, the "Phœnix" machine I compared with my own was supplied to me for one of my clients, and it is constructed to work 40 incandescent lamps, each taking 60 watts. I have nothing to do with "carcase dimensions," which, when wound, will give or "produce" certain results *for a short space of time*. I might argue in the same way as Mr. Esson does in regard to the carcases of my machines. Does anyone think that Messrs. Paterson & Cooper are so very liberal as to give me a dynamo having an output of 5,500 watts, when I only ask for one of 2,400 watts (a 40-lighter)? What I have stated in regard to the performance of the two machines, my own and the Phœnix, is perfectly correct, as will be seen on referring to the catalogue of Messrs. Paterson & Cooper, published at the end of 1884. If you would kindly insert a copy of the following letter addressed to Messrs. Paterson & Cooper I think it will clear up the matter.

(COPY.)

Bowdon, 12*th November*, 1885.

Messrs. Paterson & Cooper,
76, Little Britain, London, E.C.

Gentlemen,—Please let me know your lowest price for compound wound Phœnix machine to give 50 volts at terminals, and to work up to 40 20-C.P. lamps. The machine will only be required to work 30 lights, or even less than this, but must be capable of working the full number, viz., 40 lights, in case this number are put in circuit. Please say what is the *best* you can do, and oblige,

Yours faithfully,
(Signed) CHARLES LEVER.

It is needless to say more than that the dynamo was purchased, and this is the same machine, the particulars of which I sent you.

With regard to the letter from a Mr. H. Jones, which appeared in last week's REVIEW, I can only say that having seen his specification, I am utterly astounded that he should liken his machine to mine. All that Mr. Jones claims is a laminated Siemens shuttle-wound armature, with laminated field-magnets; and I send you his specification in order that you may see his own drawings. There is not a word in Mr. Jones's specification to the effect that any projecting part of the armature plates revolve in grooves in the pole pieces, and his own drawings show that this would be impossible. In conclusion let me say, that the different businesses with which I am connected take up too much of my time to enable me to enter into any discussions with your correspondents. I have simply claimed a specific method of constructing an armature of the Pacinotti or polar type, running in grooves in the pole pieces; and I repeat what I have already stated, viz., that as far as I have been able to investigate the matter, Mr. Hookham is the only inventor who, I believe, has constructed a dynamo like mine, and I feel justified in my assertion, as this gentleman has not proceeded with his patent application since the appearance of my publication.

Charles Lever.

Schanschieff's Battery.

In Mr. W. H. Preece's report on the Schanschieff battery no mention is made by him as to the cost of the fluid to the users of this battery. He states that he has been testing and examining the battery for several months, and that a very accurate series of measurements were made with a battery which produced a 1 candle-power light for 8 hours at a cost of materials consumed of 1d., and we are further told that the residue of this battery can be sold in the market or sent back to the Schanschieff Co., who will recuperate it and take in exchange in part payment for additional solution.

Now Sir, all this sounds very well to the uninitiated, but what we require to know is:—

1. What is the cost of the Schanschieff fluid per gal.
2. What quantity of fluid is wanted to run, say a 5 candle-power lamp for 8 hours consecutively or intermittently.
3. What amount will the manufacturers allow for the spent fluid when returned to them.
4. Who defrays the cost of carriage to the manufacturers.

5. Where can the residue be sold in the market, who are the likely buyers, and at what price per gallon.

Perhaps those gentlemen mostly interested in the Schanschieff battery will answer these questions, as they seem to me to be of more importance than the question whether the battery consumes an ounce or two of zinc more or less.

The transport of fluid from the consumer to the manufacturer, and *vice versa*, must of necessity be a heavy item, and should be added to the cost of the light. One gallon of fluid is conveyed by the various parcels' delivery in London at from 6d. to 8d., and from London to the country from 8d. to 1s. 6d. the gallon, according to the distance. It would cost either the consumer or the manufacturer from 1s. to 3s. per gallon for carriage for the double journey, and more if it were sent over 400 miles.

In the interest of primary battery inventors I should like to know what Mr. Preece has to say to this.

W. E. Moser.

November 29th, 1887.

The Society of Telegraph-Engineers and Electricians.

It is gratifying to learn that the Society of Telegraph-Engineers and Electricians has under consideration the advisability of altering its title and of increasing the frequency of its meetings.

Neither of these points is unimportant; but it would be vain, I imagine, to contend that any reformations respecting them could render the society fit to adequately meet the requirements of the day. I am afraid, and I write as a sincere friend of the society, that far more drastic measures are necessary if it is to preserve its position as the electrical parliament of the British Empire. Probably I shall not err greatly in stating that the weakest points of the society are as follows:—

(1) It is, to most intents and purposes, a London Institution. Provincial and Colonial members have no opportunities of partaking in the discussions, and, as a rule, do not become acquainted with the details of its proceedings until the issue of the journal. They receive notices of the meetings, with the titles of the papers to be read, but for the contents of the papers they have to wait weeks, sometimes months. Young provincial electricians are deterred from joining by the fact that in some parts—Scotland, for instance—members are so few that opportunities of becoming acquainted with, and obtaining the necessary recommendations of a sufficient number of such gentlemen, are extremely rare.

(2) Its meetings are too few and the range of subjects dealt with too limited. However, this objection appears about to be removed.

(3) The time devoted to the meetings is too short. Exhaustive discussion of papers is consequently impracticable. As a rule, a few prominent members, generally committee men, speak for a few minutes each, and the discussion closes. Sometimes a discussion on a very interesting subject is continued at the following meeting, but usually only at the expense of the next paper on the list.

All this will probably be admitted, and the question of how to remedy it, asked. I do not pretend to furnish a complete answer, but I have ideas on the subject, the airing of which will do no harm if it does no good.

I am persuaded that the Society must cease to be practically a London one. Already the formation of a Scottish Electrical Society has been mooted, and it may be taken for granted that other divisions of the kingdom will not be backward in following such an example if once it were set. But I also consider that it is possible for the Society of Telegraph Engineers and Electricians to render such secessions unnecessary by modifying its constitution somewhat on the following lines:—

Let the country be mapped out into districts, each division having an important town as its centre, and let honorary secretaries and committees be appointed in each district. For example, in Scotland four such divisions would be desirable, having respectively Edinburgh, Glasgow, Dundee and Aberdeen for their centres. In England, the number of divisions would probably require to be greater. There are now so many electricians employed in connection with the universities, the Post Office, the railway, telephone and electric light companies, besides those in business on their own account, that no difficulty need be apprehended in forming a nucleus in each division. With the extension of existing electrical industries and the introduction of new ones, their numbers are bound to increase at an ever accelerating rate. Let the papers accepted for reading in London be printed, and copies forwarded to each centre to be read by the local secretaries at local meetings held simultaneously, or as nearly so as possible, with the London one. Discussions on each paper will then be forthcoming at every centre, and instead of remarks from three or four gentlemen in London, criticisms will be had from at least twenty times that number. These discussions should be forwarded to London, and the essence of them selected by the editing committee for publication in the journal. Possibly the greater portion of the provincial discussions may not prove of much value—at least at first—but here and there unexpected light is certain to be revealed. If oysters were never opened, pearls would never be found. Let the Society fish for electrical pearls over as wide an area as possible, and, depend upon it, the labour will not be in vain. Any deficiency in the earlier discussions would simply illustrate the truth of the aphorism that to reap one first must sow. The system would afford provincial electricians opportunities for improving themselves and each other, which are now entirely lacking. It would teach them to think, to express their ideas, and to take interest in other branches of the science besides their own special ones. It would educate them, in fact, as men only can be educated who possess facilities for the free interchange of ideas. Certainly in the past opportunity as often as necessity has been the mother of invention. The scheme might possibly be made to include the circulation amongst the provincial centres of books from the Society's library, which at present exists for London alone. I would have all subscriptions payable in London, as at present, and all papers sent to London for acceptance before being read. Eventually the system might be extended to the colonies and to India.

It may be objected that the execution of such a programme would involve great expense; in fact, that it would not pay. I should accept neither proposition. A large addition to the membership and consequently to the revenue could not fail to result from the operation of the system, while disbursements at the centres, with good management, could be kept within very narrow limits. The local officials would be honorary; there would be no difficulty in most towns where Universities, railway, and electrical companies exist, in procuring the use of a suitable meeting room, either free or for the cost of the gas and attendance. An office for the use of the local secretary, and to provide a fixed local address, might be necessary, but its cost would be insignificant. Beyond this, and the cost of reporting the discussions and of postage, there would be but few items to meet. The expense of printing the papers beforehand for distribution would be trivial, as the type set up for that purpose could afterwards be used for printing the journal. I am, of course, aware that all papers could not be read effectively in 20 places at once. Some require to be illustrated by diagrams, or by actual apparatus which could not well be multiplied; and others, very occasionally, could not be printed beforehand. But such papers form but a small proportion of the whole, and even if they did not, some sent to the country would be better than none. I am prepared to hear that I have not anticipated all the difficulties in the way; but few new schemes are entirely unobjectionable, and I should be surprised if the obstacles prove at all comparable to those which beset the formation of the society.

A. R. Bennett.

November 29th, 1887.